Rice Crop Timeline for the Southern States of Arkansas, Louisiana, and Mississippi

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INTRODUCTION

This timeline has been created to give a general overview of crop production, worker activities, and key pests of rice grown in Arkansas, Louisiana, and Mississippi. This document is intended to describe the activities and their relationship to pesticide applications that take place in the field throughout the crop cycle. Pesticide use recommendations are current as of 2002.

CROP PRODUCTION

Arkansas, Louisiana, and Mississippi rank 1, 2, and 4, respectively, for rice production within the United States. The three states had a combined total of 2,420,000 acres harvested in 2001. The value of these acres was slightly over $640,000,000 and represented 72% of the nation's total.

Short grain – Arkansas
Medium grain – Arkansas and Louisiana
Long grain – Arkansas, Louisiana, and Mississippi

Rice thrives in the warmer temperate regions of the south. It can be cultivated in almost any soil type other than deep sand. An important factor, regardless of soil texture, is the presence of an impervious subsoil layer in the form of a fragipan or clay horizon minimizing the percolation of water. The idea is to be able to maintain water in the fields which are, in essence, shallow ponds.

LAND AND SEEDBED PREPARATION

Leveling and Drainage Considerations

Fields for growing rice should be relatively level but gently sloping toward drainage ditches. Ideally, land leveling for a uniform grade of 0.2 percent slope or less provides the following: (1) necessary early drainage in the spring for early soil preparation which permits early seeding, (2) uniform flood depth which reduces the amount of water needed for irrigation, and (3) the need for fewer levees.

Importance of Early Land Preparation

Timely land preparation is essential for successful rice production. Therefore, plow fields in the summer or early fall. Early land preparation is particularly critical when high residue crops such as grain sorghum or corn are planted the year before rice. If land has been out of production and is grown up in weeds and brush, prepare the land as early as possible. Early land preparation allows several stands of grass and red rice to be killed by surface cultivation before planting.

Early land preparation incorporates the crop residue to insure good decomposition of plant material which prevents early-season nitrogen deficiency. If early land preparation is not possible, decomposition will not be at an advanced stage at planting time. Since the soil's microorganisms (bacteria, fungi, etc.) that decompose crop residue are competing with rice plants for nutrients, particularly nitrogen, the rice plant will show nitrogen deficiency. If this situation arises, additional 10-20 units of nitrogen may be required when the base fertilizer is applied at or near planting.

Seedbed Preparation

Seedbed preparation is particularly critical in the coarser textured soils. The seedbed should be well pulverized and firm to maintain proper moisture conditions for drilling and to insure rapid germination and emergence of the rice plant. Although seedbed preparation is not as critical in areas where rice is not drilled, it is still important to insure that the desired soil condition is achieved to allow rapid emergence of the rice plant. In all situations it is important to have a weed-free seedbed. To reduce costs, minimize the number of times a field is cultivated before planting. Avoid "recreational" passes over the field.

STAND ESTABLISHMENT

Uniform seedling emergence and optimum seedlings per unit area are very important in achieving good yields and quality on both main and ratoon crops. Quality of seedbed, level of seed germination, vigor of germinating seedlings, degree of uniform distribution of seed (both in depth and across the field), soil moisture, soil texture characteristics, drainage, and temperature conditions all affect stand uniformity and density. Variability in these characteristics is responsible for the wide diversity in planting methods used across the rice belt. Rice seed germination characteristics also dictate planting methods on some soil types. For example, if rice seeds are covered by soil (resulting in low light) and water (low oxygen) for extended periods, germination will not occur or will be slow and uneven. These germination restrictions are why seedbed preparation and soil drainage affect stand levels and uniformity. Rice can be drilled to moisture in coarse textured soils but must be planted shallow (or uncovered) on heavier textured soils, requiring rain or irrigation to supply moisture for germination. Most coarse textured soils will crust when drying after being water saturated.

The following are guides to assist farmers in achieving proper stands for high yield and grain quality. Their experience on each field is important in getting economical results. For example, farmers who have been successful in getting good uniform stands consistently have had some success in reducing their seeding rates. However, farmers need to be aware of the hazards of low seeding rates under their conditions before taking such measures.

SEEDING DATES

The optimum seeding dates will vary by location from year to year because of environmental conditions. Rice yields may be reduced by planting too early as well as by planting too late. Average daily temperature at seeding is crucial in stand establishment. The average daily temperature is calculated by adding the daily high and low temperatures and dividing by 2. At or below 50° F, little or no rice seed germination will occur. From 50 - 55° F, germination increases, but not to any great extent until the temperature is above 60° F. Plant survival is not satisfactory until the average daily temperature is above 65°. Based on this information and seeding date research, the optimum planting dates in the region are mid-March to late-May.

Extremely early seeding can lead to a number of problems including (1) slow emergence and poor growth under colder conditions because of the inherent lack of seedling vigor and cold tolerance in many varieties, (2) increased damage from seedling diseases (predominantly water mold) under cool conditions, (3) increased damage from birds (blackbirds, ducks and geese) which are more numerous in the early spring, and (4) decreased activity from propanil (herbicidal activity greatly reduced under cooler conditions). Extremely late seedings can also be detrimental to yield. Stand establishment can be equally difficult in hot weather. The yield potential of many varieties will decrease significantly with later seedings. Panicle blight is thought to be associated with higher than normal day and night temperatures during pollination and grain fill. Late plantings are more likely to encounter these conditions. Also, many diseases (especially blast) and insect problems are more severe, and grain quality is often decreased with later-seeded rice

SEEDING RATES

Establishing a satisfactory stand is an essential first step in a successful rice production program. The amount of seed necessary to accomplish this depends primarily on the type of seeding system (dry or waterseeded) used.

Rice can be planted in three basic ways. These are water-seeded (dry or presprouted seed dropped into a flooded field), drill-seeded (planted with a drill on 7- to 10-inch rows) and broadcast dry (broadcast on a dry seedbed by either ground equipment or airplane).

Regardless of the seeding system used, the desired plant stand is constant. The optimum stand is 10 - 15 plants per square foot, while the minimum stand is 6 - 8 plants per square foot. Rice (as most grasses) has the ability to tiller or stool. Several head-producing shoots can be formed from one plant. This is why a somewhat satisfactory stand can be produced from as few as 6 - 8 seedlings per square foot if proper cultural practices are used. Stands can be too thick as well as too thin. Excessively thick stands can often lead to more severe disease pressure and spindly plants that may be susceptible to lodging.

Based on this, recommendations are:

Planting on the basis of seeds per acre to obtain the desired plant population is more accurate than planting pounds per acre. For example, 120 pounds of Bengal or Jefferson will contain fewer seeds than 120 pounds of Cypress or Cocodrie. An ideal plant population is approximately 10 - 15 plants per square foot. Under typical conditions, about one-half of the seed survive to produce a plant. When water-seeding or dry broadcasting, about 100 - 150 pounds of seed per acre will be required. When drill-seeding, about 75 - 100 pounds of seed per acre will be required. Refer to plant growth regulator section for recommendations on reduced drill seeding rates when using seed treated with gibberellic acid. Use the higher rates when planting under less than optimum conditions.

Considerations include:

1. Use higher recommended seeding rates when planting early in the season when there is potential for unfavorably cool growing conditions. Cool conditions will favor water mold (seedling disease) in water-seeded rice. This can reduce stands. Varieties also differ in tolerance to cool growing conditions in the seedling stage.
2. Varieties differ considerably in average seed weight. Thus, a variety with a lower average seed weight will have more seed per pound. Producers may want to adjust seeding rates for this factor.
3. Where seed depredation by blackbirds is potentially high, use a higher seeding rate.
4. Where seedbed preparation is difficult and a less than optimum seedbed is prepared, use a higher seeding rate.
5. If it is necessary to use seed of low germination percentage, compensate with increased seeding rates. Always use high germination, certified seed if possible.
6. When water seeding into stale or no-till seedbeds with excessive vegetation, use higher seeding rates.
7. If any other factor exists which may cause stand establishment problems (i.e., slow flushing capability or saltwater problems), consider it when selecting a seeding rate.

COMMON VARIETIES

Decisions on variety selection are some of the earliest and most critical you will make. This information will help you decide which rice varieties are best suited to your particular growing conditions.

The varieties are grouped on the basis of grain type (long or medium). After each variety name are letters in parentheses to indicate the state of origin. The long grains are divided into two groups based on relative maturity. A brief description of the agronomic characteristics of each of the recommended varieties is provided. In addition to recommended varieties, descriptions of other varieties may be included for the various maturity groups. These are varieties that are not recommended but may be grown on limited acreage.

Recommended Long Grain Varieties

Cocodrie (LA) - Cocodrie is a very early, semidwarf long grain variety that has displayed excellent yield potential. It is about the same height as Cypress but has displayed somewhat better resistance to lodging. Cocodrie averages 4 - 5 fewer days to 50 percent heading than Cypress. The new variety has displayed good second crop potential. It has displayed good milling characteristics and good seedling vigor. Cocodrie is susceptible to sheath blight and straighthead and moderately susceptible to blast.

Jefferson (TX) - Jefferson is a semidwarf long grain that is approximately three to four days earlier than Cocodrie. It is about the same height as Lemont and is highly resistant to lodging. Milling yields are good, but seedling vigor is poor. Shallow seeding and/or gibberellic acid seed treatment will enhance establishment. Jefferson is susceptible to sheath blight and moderately susceptible to blast. Because of the larger seed size and lower seedling vigor of this variety, the planting rate should be increased by 15 percent.

Maybelle (TX) - Maybelle is the earliest variety recommended for Louisiana production. Although Maybelle is not a true semidwarf, it is moderately resistant to lodging. It displays very good seedling vigor, especially in a water-seeded system. It has good first crop potential and excellent ratoon yield ability. Maybelle is susceptible to blast and sheath blight.

Wells (AR) - Wells is a newly released short stature long grain variety. It has displayed excellent yield potential in tests throughout the rice growing areas of Louisiana. Milling yields are normally good, but Wells has demonstrated sensitivity to low harvest moisture, resulting in lower milling yields. Seedling vigor is excellent. The variety is similar in maturity to Cypress (1 - 2 days earlier). Wells is 2 - 3 inches taller than Cypress but has good straw strength and stands quite well. The variety is rated as moderately resistant to blast and susceptible to sheath blight.

Cypress (LA) - Cypress is a semidwarf, long grain variety. It is slightly taller than Lemont and may be slightly more susceptible to lodging. Cypress has displayed excellent first crop yield potential and has also exhibited good second crop yield potential. It has displayed excellent milling characteristics and extremely good seedling vigor. Cypress is susceptible to sheath blight and blast. This variety is also susceptible to panicle blight, a physiological disorder that causes abortion of the developing grain.

Other Long Grain Varieties

Ahrent (AR) - Ahrent is a very early long grain variety that is slightly earlier than Cocodrie. It has shown good yield potential and milling quality. Ahrent is similar to Wells in plant height and appears to be similar in lodging susceptibility. The variety is rated resistant to blast and moderately susceptible to sheath blight. Seedling vigor appears to be good.

Drew (AR) - Drew is an early long grain variety with excellent resistance to blast disease. It averages about 5 inches taller than Cypress and has displayed very good yield potential. It is rated susceptible to sheath blight and moderately susceptible to lodging. It has shown good second crop potential in limited testing.

Jackson (TX/MS) - Jackson is closely related (sister line) to Maybelle, but it is 7 - 10 days later in maturity and 2 - 3 inches taller than Maybelle. Jackson also has a distinctly longer flag leaf. Reactions to sheath blight and blast disease are similar to Maybelle. Second crop potential is very good.

LaGrue (AR) - LaGrue is about 43 inches tall and moderately susceptible to lodging. LaGrue has exhibited good yield potential. Milling yields were variable, generally averaging less than recommended varieties in this maturity group. LaGrue is susceptible to blast and sheath blight. Maturity is slightly earlier than Lemont and Cypress.

Lemont (TX) - Lemont is a semidwarf that has excellent milling characteristics but poor seedling vigor. Shallow seeding depth is essential. Because of the short plant height and good straw strength, Lemont is highly resistant to lodging. Lemont is very susceptible to sheath blight and susceptible to blast. Lemont has shown very good ability to tiller (stool) and good second crop potential.

Priscilla (MS) - Priscilla is a semidwarf early long grain variety that has shown good yield potential. It is approximately the same height as Cypress but is somewhat more resistant to lodging. The variety is slightly earlier than Cypress and slightly later than Cocodrie in maturity. Priscilla is somewhat more resistant to sheath blight than Cypress. Milling yields are fair and seedling vigor is good.

Kaybonnet (AR) - This conventional height, early long grain variety has displayed excellent yield potential and good milling characteristics. The variety has very high levels of resistance to most races of blast common to the south. Kaybonnet is rated as susceptible to sheath blight disease and moderately susceptible to lodging. It has displayed good second crop potential.

Saber (TX) - Saber is an early long grain variety that has been between Cocodrie and Cypress in days to 50 percent heading in field testing. However, the variety ripens quickly after heading and will reach harvest maturity in about the same period as Cocodrie. Saber has averaged slightly lower than Cypress in grain yield but has displayed excellent milling quality and grain appearance. Saber is rated resistant to blast and moderately susceptible to sheath blight. The variety is slightly taller than Cocodrie and Cypress.

Rico 1 (TX) - This variety has excellent yield potential and good milling performance. It has typically yielded higher than other recommended medium grain varieties in yield trials. It is a tall variety and is susceptible to lodging, especially if nitrogen fertilization rates are too high. Seedling vigor is fair. It ripens very slowly. It is moderately resistant to straighthead, moderately susceptible to sheath blight and susceptible to sheath rot and blast. Short, plump grains characterize Rico 1, making it more difficult to dry under certain conditions. It also tends to produce chalky grains, especially under high nitrogen fertilization. As a result, some mills may be reluctant to accept it.

XL6 (RiceTec) - XL6 is a long grain rice hybrid that has displayed very high yield potential. Milling quality is fair to poor, and cooking quality is typical of southern long grain varieties. Seedling vigor is excellent. XL6 is very susceptible to lodging and is not recommended for water seeding because this increases lodging potential. Nitrogen requirements are low, and lodging potential will be increased when excessive nitrogen is applied. XL6 has shown high levels of resistance to most major rice diseases.

CL121, CL141 and CFX18 are Newpath-resistant rice varieties that have been developed for use in the Clearfield system for the control of red rice. This system is discussed in the Weed Control section of this publication.

CL121 (LA) - CL121 is a very early, semidwarf, long grain rice variety. It has averaged 4 - 5 days earlier than Cocodrie in days to 50 percent heading, making it similar to Jefferson. The variety has displayed good milling yield and quality. It is highly resistant to lodging. CL121 has shown good second crop potential in limited testing. The variety is rated moderately susceptible to blast and susceptible to sheath blight.

CL141 (LA) - CL141 is a tall, early long grain rice variety. It is similar in height to Drew and rated as moderately susceptible to lodging. It is similar to Cocodrie in maturity and has shown good second crop potential in limited testing. Grain yield is good, and grain quality and appearance are very good. CL141 is rated susceptible to sheath blight and susceptible to blast.

CFX18 (LA) - CFX18 is a high yielding, high quality, long grain rice variety. It is very similar to Cypress in appearance and maturity but averages two to three days later in days to 50 percent heading. The variety is also very similar to Cypress in yield and milling potential, but grain size is smaller. The variety is rated susceptible to sheath blight and moderately susceptible to blast.

Jodon (LA) - Jodon is a semidwarf, long grain variety that is a sister line to Cypress. It has displayed good levels of resistance to lodging but may lodge more readily than Lemont-type semidwarfs. This variety has very good seedling vigor and excellent first and second crop yield potential. Milling yields are generally fair to good. Jodon is susceptible to sheath blight and blast and to straighthead. Jodon has amylographic characteristics similar to L-202, which may make it cook slightly softer than other long grains and, thus, be unsuitable for canning processes.

Medium Grain Varieties

Bengal (LA) - Bengal is a semidwarf variety that has displayed very good yield potential and excellent milling quality. The milled grains are plumper than other commonly grown medium grains in the South, a characteristic favored for some processing uses. Seedling vigor is good, and Bengal has displayed good but variable second crop yield potential. It is susceptible to blast and straighthead and moderately susceptible to sheath blight. Bengal has also displayed susceptibility to panicle blight.

Earl (LA) - Earl is a conventional medium grain variety that has displayed very high yield potential and fair to good milling and grain appearance quality. The variety is moderately resistant to the predominant races of blast disease. Earl has good seedling vigor and has demonstrated good ratoon potential in limited testing. The variety is taller than most currently grown varieties, and care should be taken to avoid excessive rates of applied nitrogen fertilizer because this could increase the potential for lodging.

Other Medium and Short Grain Varieties

Lafitte (LA) - Lafitte is a short-statured medium grain that is 5 - 6 days earlier in maturity than Bengal. It is 2 - 3 inches taller than Bengal and is more susceptible to lodging. The variety has displayed good stable yields and consistently higher head rice yields in testing. Lafitte is resistant to the currently predominant blast races. Seedling vigor is good and the variety has displayed good second crop potential in limited testing. The variety is moderately susceptible to sheath blight and susceptible to straighthead.

S-102 (CA) - S-102 is a short grain variety that is being grown on a contract basis in Louisiana. It is very early, has good yield potential and excellent seedling vigor. The variety is susceptible to lodging, and nitrogen rate management is very important. Milling yields are good, but the grain can display some chalkiness. S-102 is very susceptible to rotten neck blast disease.

Saturn (LA) - Saturn is an old (released in 1964) medium grain variety still grown in the deep southern portions of the growing region. The variety has good seedling vigor but is tall and extremely susceptible to lodging. Saturn has moderate yield potential and excellent milling characteristics.

Special Purpose Long Grain Varieties

**Because of the unique characteristics of these special purpose long grains, they should not be commingled with standard U.S. long grain varieties.*

Della (LA) - Della is an aromatic long grain that many consumers favor for its unique aroma and taste characteristics. It is grown on limited acreage in Louisiana. Della displays low yield potential when compared to other currently grown varieties. Disease susceptibility is often a problem because Della is susceptible to most major rice diseases. It is tall and is very susceptible to lodging, even under conditions of low yield potential.

Dellrose (LA) - Dellrose is a Della-type aromatic long grain variety. It is a semidwarf, early maturing variety that has displayed excellent grain, milling and ratoon yield potentials. Dellrose has good aroma and a thinner grain shape than Dellmont. Disease reaction of Dellrose is similar to Lemont. It is rated as very susceptible to sheath blight and susceptible to blast and straighthead.

Dellmati (LA) - Dellmati is a very early, tall Basmati-type long grain. The variety has excellent aroma and grain elongation characteristics and emulates imported Basmati. Dellmati displays fairly low grain and milling yield and fairly good second crop potential.

TORO-2 (LA) - TORO-2 is a special purpose, low amylose (sticky cooking) long-grain, semidwarf. In taste tests, TORO-2 was judged to have acceptable TORO-type cooking and taste characteristics. TORO-2 is resistant to the predominant blast races and moderately susceptible to sheath blight. It is also very susceptible to straighthead.

<u>PLANT GROWTH REGULATORS</u>

Plant growth regulators have several applications in rice production systems. One type of plant growth regulator can increase seedling emergence and promote shoot elongation. Another type is used to suppress red rice seed production in set aside or fallow acreage. Because of the specific activity of plant growth regulators, follow label instructions and consult your county agent before application.

Seed treatment with gibberellic acid, [**GibGro** (0.17 - 0.35 oz./cwt seed), **RELEASE** (0.35 - 0.70 oz./cwt) or **RELEASE LC** (1 - 2 fl. oz./cwt)] promotes rapid, uniform emergence in dry-seeded systems. It is especially effective on semidwarf varieties. With gibberellic acid, seeding depth can be increased up to 3 inches to minimize flushing. In drill-seeded rice, the seeding rate can be decreased to 75 - 85 lb./A when planting under warm conditions (daily average temperature higher than 70° F). Under cool conditions (daily average temperature of 60 - 70° F), the higher application rate is recommended.

Gibberellic acid [**GibGro, RyzUp** (0.0022 - .0066 lb. a.i./A)] is also labeled for foliar application in Louisiana and may be beneficial in certain situations. Follow label directions on the use of these products.

ROYAL SLO-GRO (maleic hydrazide) is labeled for red rice seed head suppression on set aside or fallow acreage. The product should be applied at 1.5 lb. a.i./A to booting and heading red rice. Read and follow label directions.

SEEDING METHODS

Seeding methods depend on soil type, weather conditions, and producer preferences. The main factors to consider in selecting seeding methods are uniformity of seed distribution and seedling emergence. These factors promote good yields as well as grain quality. There is no evidence of yield advantages for drilled versus broadcast seeding or dry versus water seeding if stands are adequate.

Water seeding describes sowing of dry or soaked seed into a flooded field. It is usually implemented for any or all of the following reasons: red rice control, wet planting season, planting efficiency and earlier crop maturity.

Water Seeding

Dry Seedbed

- seedbed prepared dry before flood establishment (clear water planting).
- prepare a dry seedbed in the spring, close levees immediately and apply floodwater.
- plant rice and release clear water.
- less wear on equipment but possible reduced weed control.

Flooded Seedbed

- seedbed prepared following flood establishment.
- close levees and flood the field; water level the field.
- the floodwater must be held in the field after all water leveling or other mechanical soil-disturbing activities have been conducted to allow for settling of suspended materials.
- plant rice and release floodwater.
- increase in equipment and labor costs but better weed control.

Stale Seedbed

- seedbed prepared three to six weeks before planting in the spring or four to five months before planting in the fall.
- may require an application of preplant burndown herbicides before planting.
- generally uses less water than the above systems at the expense of more weeds.

<u>No-till</u>

- planting directly into previous crop residue.
- may require an application of preplant burndown herbicides before planting.
- generally uses less water at the expense of more weeds.
- no mechanical soil disturbing allowed.
- Not recommended for excessive vegetation and rutted fields

Dry seeding simply describes sowing seed into a dry seedbed by drilling or broadcasting. This method usually offers more flexibility in planting but may require more time to do so. This system is also weather dependent.

<u>Conventional Seedbed</u>

- mechanical seedbed preparation using field cultivators and/or disk harrows.

<u>Stale Seedbed</u> – see above comments

<u>No-till</u> – see above comments

On fine clay soils, several seeding methods can be used, including **dry** and **water seeding**. A well-prepared, weed-free seedbed is important when rice is dry-seeded. When dry seeding with a drill on fine clay soils, flush the field immediately after planting to ensure uniform emergence. Seed can be broadcast on a rough, cloddy seedbed if followed immediately with a flushing so soil clods disintegrate and cover the seed. This allows good germination and uniform emergence. Broadcast seed on a well-prepared seedbed, followed by dragging to cover the seed, is possible in some areas. This also requires immediate flushing of the field so that emergence is uniform. If rice is water seeded, the seedbed may be left in a rough, cloddy condition since flushing breaks up clods and provides some seed coverage.

Although all of these planting methods can be used for the semidwarf varieties, experience has shown that shallow planting is much better for good stand establishment for these varieties. For example, do not drill any deeper than necessary on coarse soils. Although soil crusting conditions cannot always be avoided, use proper management to prevent this condition.

EARLY FLOOD RICE CULTURE

Definitions

Two different systems are used to produce rice with early flood culture. One system is **continuous flood**; the other is **pinpoint flood**. In the continuous flood system, sprouted seed are dropped into a flooded field that is maintained until near harvest. In the pinpoint system, dry or preferable sprouted seed are dropped into floodwater. The field is drained after 24 hours and left dry for 3 - 5 days to provide oxygen and allow the roots to anchor or "peg" to the soil. Then the flood is re-established and maintained until near harvest. For the rice plant to continue growth, a portion of the plant must be above water by at least the fourth leaf stage.

The advantages of applying water to a field and retaining it throughout the growing season are: (1) easier water management and less water use, (2) red rice and grass suppression, (3) less seedling stress from cool weather, (4) elimination of early-season blackbird problems, (5) reduction in seedling loss due to salt, and (6) increased nitrogen efficiency, when nitrogen is applied to dry soil before flooding.

When a **delayed flood** is used, fields are drained after water seeding for an extended period (usually 3 or 4 weeks) before the permanent flood is applied. With this system, fertilization timing and water management after the initial drainage are similar to dry-seeded systems.

Land preparation and stand establishment

A problem that may be encountered with both systems is the presence of aquatic weeds late in the season and stand establishment in unlevel cuts where water may be too deep or seed is covered with too much soil. In addition, the continuous flood technique has the following disadvantages: (1) possibility of seedling damage from rice seed midge, (2) seedling drift, especially in large, open cuts, and (3) the cost of calcium peroxide coating.

Prepare land in fall or as early as possible in the spring so that vegetation can be turned under and decompose prior to planting. This prevents oxygen depletion during germination when the soil is flooded. Since cool water contains more oxygen than warm water, it is desirable to plant early in the season before floodwater gets warm.

To minimize seedling drift in the continuous flood technique, it is suggested that the soil surface be "grooved" before flooding by pulling a spike-tooth harrow to create ridges in the soil. A compacting groover can also be used to create ridges. The groover compacts the soil surface to stabilize the ridges for more uniform stand establishment and efficient field drainage. Seeds usually settle between ridges, where they are less likely to drift.

Muddying floodwater through mechanical tillage just before applying seed is another method for minimizing seedling drift. The suspended soil will slightly cover and help anchor the seed. A relatively cloddy soil surface minimizes seedling drift better than a “mirror smooth” soil surface.

Water Management

It is important to flood the soil immediately after the seedbed preparation. A delay in flooding allows red rice and other weeds to establish before flooding, and increases seed midge development.

Keep the area between the levees as uniformly level as possible. If the water depth in a cut is less than 2 inches in the shallow area and greater than 6 inches in the deep area, the crop will not emerge and mature uniformly. Try to maintain a uniform flood depth of fewer than 4 inches (1 or 2 inches is preferable) before rice emergence. As rice gets taller, increase to 4 inches.

RICE FERTILIZATION

Generally lime is not recommended for rice production unless the pH of the soil is 4.9 or lower. Crops grown in rotation with rice such as cotton, soybeans and other pH sensitive crops may benefit from liming. The pH of the soil should not be increased to more than 5.8 for rice production. Overliming can induce zinc deficiency in rice.

Phosphorus and potassium should be applied according to soil test recommendations. On soils where phosphorus and potassium are needed, apply preplant or before first flood. Potassium deficiency has been associated with increase in disease incidence and severity. Fertilizer nutrients are most efficiently used by rice when applied immediately before permanent flood establishment. There are situations when fall application of some nutrients may be a suitable alternative. However, neither nitrogen nor zinc should be applied in the fall.

Rice seedlings usually show nitrogen deficiency within 15 - 25 days after seeding, especially in soils low in organic matter. A preplant application of 15 - 30 pounds of nitrogen per acre is usually needed to meet the seedling nitrogen requirement before permanent flood.

All or most of the nitrogen can be applied preplant in a water-seeded pinpoint flood system. In a drill-seeded, dry broadcast or water-seeded delayed flood system, all or part of the nitrogen may be applied immediately before permanent flood. The balance of the nitrogen can be applied when deficiency symptoms occur or anytime up to the panicle differentiation (2 mm panicle) growth stage. Avoid applying nitrogen-containing fertilizers more than seven days before planting.

Rice varieties may differ in their nitrogen requirements by location. Native soil fertility, soil type and other factors determine the efficiency of nitrogen. Rice growers should determine the N rate that provides optimum grain yield on their land. The higher nitrogen rates within the recommended ranges for each variety are generally required on clay soils. Avoid N deficiency and excessive N fertilization.

Varieties vary in their nitrogen needs as follows. These recommendations are based on multi-year, multi-location research throughout the southern region. These rates assume proper timing.

On soil with a history of zinc deficiency, or where soil tests indicate a need for zinc, a soil application of 7 - 8 pounds of zinc from an inorganic source (zinc sulfate) or 1 - 2 pounds of zinc per acre as a chelate should be made. Zinc can be applied foliarly at the rate of 0.5 - 1.0 pound per acre as a chelate. Sulfur may be needed at a rate of 20 - 25 pounds per acre where large amounts of soil have been moved in land leveling. Sulfur deficiencies resemble nitrogen deficiencies, producing pale yellow plants that grow slowly. If these symptoms appear, applying 100 pounds of ammonium sulfate per acre will provide 21 pounds of nitrogen and 24 pounds of sulfur per acre.

RATOON CROP

Certain climatic conditions along with the early maturity of commonly grown varieties allow for a second or ratoon crop during a single growing season. This ratoon crop is produced from the re-growth of the previously harvested crop.

Weather is a critical factor when determining how successful a ratoon crop will be. Mild conditions will speed second crop maturity. Later than normal frost-dates will also aid in producing a second crop. This explains the success of ratoon crops in southern Louisiana and why Arkansas does not ratoon crop.

Fertility is the major cultural management practice of the second crop. Ratoon rice should be fertilized with 45 - 75 pounds of nitrogen per acre when first crop harvest is before August 15. When the first harvest is after August 15, fertilize with 30 - 45 pounds of nitrogen per acre. When conditions appear favorable for good second crop production (minimal field rutting, little or no red rice, healthy stubble), apply the higher rate of nitrogen. Apply nitrogen and establish a shallow flood within five days after harvest. When the main crop is harvested after August 15, the potential for profitable second crop production is reduced because of the increased likelihood of unfavorable weather.

Broadleaf weeds such as dayflower may become a concern in ratoon rice. See weed control section for herbicide recommendations.

CROP ROTATION

Several crops can be used in rotation with rice. Soybean is one of the more popular throughout the region. Wheat can be seen in Arkansas. Cotton is also an option for Northeast Louisiana and parts of Mississippi. To a lesser degree, corn and sorghum are used as rotations.

Some farmers do not choose to rotate. Continuous rice culture can worsen weed problems such as red rice. Since growers aren't rotating into soybeans, they cannot rotate herbicides that help fight red rice. Mississippi State University weed scientist Mark Kurtz conducted an eight-year study evaluating rice-soybean rotation patterns. After the third year of continuous rice, yields dropped off significantly and never rebounded.

Aquaculture rotations such as rice/crawfish/rice are often utilized in Louisiana with as many as 30,000 acres in such a rotation.

WORKER ACTIVITIES

Land Preparation – This information can be obtained from the 'Crop Production' section of this report. When operating mechanical equipment there is a very slight risk of operator injury when dealing with the manual adjustment of the plowing equipment - tightening of bolts, etc. With a wrench, an operator could bruise the knuckles if the wrench were to slip - only a minor injury.

Planting Methods –This information can be obtained from the 'Crop Production' section of this report. Only rare cuts, scrapes, and bruises would occur in the adjustment of planting equipment. It would be likened to the carpenter who occasionally hits his thumb with a hammer - only a minor injury.

Cultivation – Cultivation practices prior to planting are covered in the 'Crop Production' section of this report. Due to the growth habit and flood culture of rice, mechanical cultivation after planting does not exist.

Fertilization/Pesticide Application – This information can be obtained from the 'Crop Production' section of this report. Take necessary precautions in handling fertilizers, lime, etc.

At one time, flaggers were used to assist in aerial application of pesticides. However, with the advent of GPS (Global Positioning System) tracking systems, flaggers are rarely, if ever, used. The only time an operator would come in contact with pesticides is when loading the spray equipment, i.e., the spray tank of the equipment. Assuming proper PPE, risk is minimal.

Approximately 75-85% of all pesticides are applied by air. Roughly 20-25% is still applied by land. Pre-plant incorporated herbicides are applied with ground equipment.

Irrigation – Irrigation in rice is essentially managing or maintaining the floodwater. This is accomplished through pumping coupled with ditch, canal, and levee management.

Scouting – The only time workers are in the field and not on a piece of heavy machinery usually involves pest monitoring. ATV's (all terrain vehicles) are frequently used to assist with insect, weed, and disease monitoring as well as flood control. Conceivably a worker could have an injury involving an ATV. However, the speed at which one travels in a rice field is so slow, injury rarely if ever happens.

Harvesting – Premature harvesting of rice keeps the grain from reaching maturity, and can cause serious losses in the quality of the product. Furthermore, it is important to accomplish the harvest while the moisture content of the grain is acceptable. Using moisture sensors, the moisture content should be 17 - 22%. Too low a moisture content can cause the panicles to shatter at the time of cutting leading to serious losses of product.

Combine harvesters or simply 'combines' are machines that do the cutting, threshing and pre-cleaning of the rice in one operation. Self-propelled with an enclosed and often temperature regulated cab, combines have a cutting apparatus, a threshing chamber composed of a revolving threshing drum (with teeth), and a stationary counter-thresher. Two major types are used: a conventional setup and a stripper-header. There are variances among augers and feeding mechanisms among the two. Generally the stripper-header offers considerably faster harvesting, but it does have drawbacks. It is more expensive, heavier to operate, and is limited to small grains (rice, wheat, oats, etc.) This makes it difficult for a grower who wishes to use the same combine for another crop such as soybeans in rotation with rice.

Generally, a minimum of 4 - 5 people are involved in rice harvesting: one to operate the combine, one to drive a grain cart, and two or more to drive the trucks to the grain elevator for drying and storage in bins. Depending on equipment used and field conditions, 25 - 50 acres may be harvested in one day.

There are times when the combine will become clogged and require manual removal of debris from the header or cutter mechanism. Cuts, bruises, and abrasions can occur as a result. In rare cases, a fatality can occur when an operator, who does not properly shut off the header mechanism, attempts to remove debris from the header. This occurred more often in years past, but due to more safety features of the equipment, including automatic shutoff devices, fatalities are rare. Institutions that gather agricultural statistics such as the USDA and NIOSH (The National Institute for Occupational Safety and Health) do not carry data specific to rice combine injuries and fatalities. However, state rice specialists agree the occurrence of fatalities involving rice combines is declining.

INSECTS

Insects can be a major factor limiting rice production in Louisiana. The rice water weevil and the rice stink bug are key pests. They cause significant reduction in the quantity and quality of rice produced each year. Other insects attacking rice, though not key pests, can occasionally reduce rice yield and quality significantly. These include the rice seed midge, rice leaf miner, fall armyworm, chinch bug, rice stalk borer, and sugarcane borer.

This section contains information about the identification, life cycle, injury to rice, and current scouting and management practices for these pests. The scouting and management recommendations are based on the best available information and will be modified as additional research is conducted. Rice insect control recommendations are summarized in this section, but consult your county agent to get the latest recommendations for specific insect pests.

Rice Water Weevil, ***Lissorhoptrus oryzophilus*** **(Kuschel)**

Description and Life Cycle: The rice water weevil is one of the most injurious insect pests in rice production. Yield losses of more than 1,000 pounds per acre can occur from severe infestations. Rice water weevil adults are grayish brown beetles about $^1/_8$ -inch long with a dark brown V-shaped area on their backs. They overwinter as adults in grass clumps and ground debris near rice fields. Wing muscles of overwintering adults degenerate so these insects cannot fly. When spring temperatures rise to 65° F, wing muscles begin to regenerate and adults begin moving out of overwintering sites. Adults fly in the early evening, with little flight occurring when night temperatures fall below 60° F.

Adults will invade either unflooded or flooded rice fields and begin feeding on the leaves of rice plants. The flight muscles degenerate again as the weevils become established, and the adults cannot fly. Females begin egg laying in flooded fields or in areas of unflooded fields that contain water, such as low spots, potholes or tractor tire tracks. Females deposit white, elongate eggs in the leaf sheath at or below the waterline. White, legless, C-shaped larvae with small brown head capsules emerge from the eggs in about seven days.

First instar larvae are about $^1/_{32}$ inch long and feed in the leaf sheath for a short time before exiting the stem and falling through the water to the soil. Afterwards, they burrow into the mud and begin feeding on the roots of rice plants. The larvae continue to feed in or on the roots of rice plants developing through four instars in about 27 days. Larvae increase in size with each succeeding molt. Fourth instar larvae are about $^3/_{16}$ inch long. Larvae pupate in oval, watertight cocoons attached to the roots of rice plants. The cocoons are covered with a compacted layer of mud and resemble small mud balls.

Adults emerge from the cocoons in 5 - 7 days, are able to fly a short time after emerging and may attack rice in the same or a different field. The life cycle from egg to adult takes about 35 days. The length of the life cycle is temperature-dependent, however, and can vary from 25 - 45 days in warm and cool weather, respectively. The number of generations per year varies with latitude. Two and a partial third generation can occur in the southern rice-growing areas of the region. One and a partial second generation occur in the northern rice growing areas. Most adult weevils emerging in late July to early August fly to overwintering sites and remain inactive until the next spring.

Injury: Adult rice water weevils feed on the upper surface of rice leaves, leaving narrow longitudinal scars that parallel the midrib. Adult feeding injury can kill plants when large numbers of weevils attack very young rice, but this is rare and is usually localized along the field borders. Larvae feeding in or on rice roots cause most economic injury. This feeding or root pruning reduces root surface area, resulting in decreased nutrient uptake by the plant. Plants with severely pruned root systems turn yellow and appear to be nitrogen deficient. At harvest, plants from heavily infested fields will be shorter than normal and have lower yields. Each larva found in a 4-inch (diameter) by 3-inch (deep) core sample reduces rice yield by 40 pounds per acre.

Scouting and Management: With the loss of carbofuran as a chemical control for rice water weevil in rice, larval counts are no longer used as a sampling procedure. *Icon* as a preventative seed treatment is a newer insecticide now used against larvae. If *Icon* is not used, upon sampling the field, any presence of an adult rice water weevil warrants spraying of a foliar insecticide if conditions are favorable for oviposition. Foliar insecticides such as *Karate Z* and *Fury* are labeled for use and should be aimed to kill adults before they lay eggs. Most of oviposition occurs when there is water in the field. Therefore, control is recommended when: (1) Adults are present, and (2) there is water in the field (flood), or there will be water soon. Previous research also indicates that you can apply *Karate Z* when adults or fresh feeding scars are present within 24 hours before permanent flood and still obtain good control.

Management of the Rice Water Weevil using Cultural Control: Fields may be drained to reduce rice water weevil numbers. Draining fields is the only rice water weevil control method available for rice grown in rotation with crawfish. This procedure requires careful planning so conflicts with weed, disease and fertilizer management programs can be avoided or minimized

The Stem Borers

Rice Stalk Borer, *Chilo plejedellus* (Zink)
Description and Life Cycle: The rice stalk borer is a sporadic pest of rice in the south. These borers overwinter as last instar larvae in the stalks of rice and other host plants. Larvae pupate in the spring, and adult moths emerge in early to late June, mate and live on various hosts until rice stem diameter is large enough to support tunneling larvae. Adults are about 1 inch long with pale white fore and hind wings tinged on the edges with metallic gold scales. Front wings are peppered with small black dots. Although egg laying may begin in late May, injurious infestations usually occur from August through September. Flat, oval cream-colored eggs are laid in clusters of 20 - 30 on the upper and lower leaf surfaces. Eggs are laid at night over 1 - 6 days. Larvae emerge in four to nine days and crawl down the leaf toward the plant stem. Larvae may feed for a short time on the inside of the leaf sheath before boring into the stem. They are pale yellow-white with two pairs of stripes running the entire length of the body. These stripes distinguish rice stalk borer larvae from sugarcane borer larvae, which have no stripes. Mature larvae are about 1 inch long. Larvae move up and down the stem feeding for 24 - 30 days before moving to the first joint above the waterline, chewing an exit hole in the stem and constructing a silken web in which to pupate. Pupae are about 1 inch long, brown and smoothly tapered. There are two to three generations per year in rice.

The Sugarcane Borer, *Diatrea saccharalis* (F.)
Description and Life Cycle: The sugarcane bore is also a sporadic pest of rice in the south. Like the stalk borer, sugarcane borers overwinter as last instar larvae in the stalks of rice and other plants. These larvae pupate in the spring,

and adult moths emerge as early as May. They mate and live on various hosts until rice stem diameter is large enough to support larval feeding. Adults are straw-colored moths about 1 inch long with a series of black dots, arranged in a V-shaped pattern, on the front wings. Egg laying on rice can begin as early as May, but economically damaging infestations generally do not occur until August or September. The flat, oval, cream-colored eggs are laid at night in clusters of 2 - 100 on the upper and lower leaf surfaces over 1 - 6 days. Larvae emerge in 3 - 5 days, crawl down the leaf and bore into the plant stem. They move up and down the stem, feeding for 15 - 20 days before chewing an exit hole in the stem and pupating. Larvae are pale yellow-white in the summer, with a series of brown spots visible on the back. Overwintering larvae are a deeper yellow and lack the brown spots. The lack of stripes distinguishes sugarcane borer larvae from rice stalk borer larvae, which have stripes in winter and summer. Mature larvae are about 1 inch long and do not enclose themselves in a silken web before pupation. The pupae are brown, about 1 inch long and roughly cylindrical in shape, not smoothly tapered, as are rice stalk borer pupae. Overwintering sugarcane borer larvae are usually found closer to the plant crown than rice stalk borer larvae. The pupal stage lasts 7 - 10 days. There are 3 generations per year.

Injury: Injury to rice results from stalk and sugarcane borer larvae feeding on plant tissue as they tunnel inside the stem. Injury is often first noticed when the youngest partially unfurled leaf of the plant begins to wither and die, resulting in a condition called deadheart. Later in the growing season, these rice stems are weakened and may lodge before harvest. Stem feeding that occurs during panicle development causes partial or complete sterility and results in the whitehead condition. The white, empty panicles are light in weight and stand upright.

Scouting and Management: Unfortunately, by the time signs of field infestations (deadhearts, white-heads) are noticed, it is usually too late to apply effective chemical treatments. A seed treatment of *Icon 6.2FS* at 0.025 - 0.05 lb. a.i./A prior to planting is an effective control up to the panicle differentiation stage. For foliar sprays to be effective after crop emergence, you must time application when larvae are small before they enter rice stalks. Once larvae enter the stalks, pesticides are not effective. Extensive scouting of rice fields is required to time pesticide applications properly. Scouting can be conducted for stem borer adults or egg masses. Eggs are laid over an extended period, and although some injury may be prevented, satisfactory control using chemical treatments is difficult and has not been generally successful. Stem borer eggs and larvae are parasitized by the wasps, *Trichogramma minutum* (Riley) and *Agathis stigmaterus* (Cresson). It is believed these parasites play an important role in maintaining stem borer numbers below economic levels.

Rice Stink Bug, *Oebalus pugnax* (F.)

Description and Life Cycle: Adult rice stink bugs are shield-shaped, metallic-brown insects about ½ inch long. Rice stink bugs overwinter as adults in grass clumps and ground cover. They emerge from overwintering sites in early spring and feed on grasses near rice fields before invading fields of maturing rice. Adults live 30 - 40 days. Females lay masses of light-green cylindrical eggs on the leaves, stems, and panicles of rice plants. Eggs are laid in parallel rows with about 20 - 30 eggs per mass. As they mature, eggs become black with a red tint. Immature stink bugs (nymphs) emerge from eggs in 4 - 5 days in warm weather or as long as 11 days in cool weather. Nymphs develop through 5 instars in 15 - 28 days. Newly emerged nymphs are about $^{1}/_{16}$ inch long, with a black head and antennae and a red abdomen with 2 black bars. Nymphs increase in size with successive molts and the color of later instars becomes tan-green. Four generations per year can occur in the south - 2 on weed hosts and 2 on rice. However, only 1 generation usually develops in a given field.

Injury: Rice stink bugs feed on the rice florets and developing rice kernels. Feeding on florets reduces rough rice yields, but most economic loss results from stink bugs feeding on developing kernels. Kernel feeding results in discolored or "pecky" rice kernels that have lower grade and poor milling quality. Both adult and nymph rice stink bugs feed on developing rice grains, but adults alone account for most economic losses in rice. Relationships between stink bugs and stink bug injury developed in Texas show a strong increase in percentage of pecky rice and a strong decrease in percentage of head yield with increasing numbers of adult stink bugs during the heading period. When numbers of immature stink bugs were included, this relationship did not change.

Scouting and Management: Several natural enemies are important in reducing rice stink bug numbers in rice. Adults and nymphs are parasitized by the flies, *Beskia aelops* (Walker) and *Euthera tentatrix* (Lav.). Rice stink bug eggs are parasitized by the tiny wasps, *Oencyrtus anasae* (Ashm.) and *Telonomus podisi* (Ashm.). Management relies significantly on the activity of these naturally occurring biological control agents. Insecticidal control based on the results of field scouting is recommended when rice stink bugs escape from the control provided by natural enemies.

Rice fields should be sampled for stink bugs using a 15-inch diameter insect sweep net once each week beginning immediately after pollination and continuing until kernels harden. Do not sample fields at midday when stink bugs may be seeking shelter from the heat in the shade at or near the ground. Avoid sampling field borders, where stink bug numbers are often higher than in the field interiors. A sample consists of 10 consecutive 180-degree sweeps made while walking through the field. Hold the net so that the lower half of the opening is drawn through the foliage. After 10 successive sweeps, count the number of rice stink bug nymphs and adults. Normally 10 samples of 10 sweeps each are made per field. Alternatively, 100 random sweeps may be taken per field. During the first two weeks of heading, fields averaging one or more rice stink bugs per three sweeps (30 or more per 100 sweeps) should be treated with an insecticide. After the first two weeks of heading, treat fields when an average one or more stink bugs per sweep (100 or more per 100 sweeps) is found.

Rice Seed Midge, *Chironomus* spp.
Description and life cycle: Adult midges can be seen in swarms over rice fields, levees, roadside ditches, and other bodies of water. Adult midges resemble small mosquitoes but lack the needle-like mouthparts. They hold their forelegs up when resting. Eggs are elongate and laid in strings, usually on the surface of open water. A sticky material that forms a gelatinous coat around the eggs holds the strings together. After emerging, the larvae move to the soil surface, where they live in spaghetti-like tubes constructed from secreted silk, plant debris and algae. The larvae go through 4 instars before pupating under water in the tubes. The life cycle from egg to adult requires 10 - 15 days.

Injury: Midge larvae injure rice by feeding on the embryo of germinating seeds and on the developing root and shoot of young rice seedlings. Most economic injury to rice is the result of stand loss caused by larvae feeding on the embryo of germinating seeds. Reports of injury caused by rice seed midge have increased in recent years.

Scouting and Management: Rice seed midge is a problem only for rice seeds and seedlings in water-seeded fields. Midges are not a problem in rice more than 2 - 4 inches tall. Scout fields for midges and midge injury within 5 - 7 days after seeding. Repeat scoutings at 5- to 7-day intervals until rice seedlings are about 3 inches tall. Larval tubes on the soil surface indicate midge presence. There are many midge species, most of which do not attack rice, and the presence of midge tubes alone does not indicate the need to treat a given field.

Midge injury is indicated by the presence of chewing marks on the seed, roots and shoots and by the presence of hollow seeds. If midge injury is present, and plant stand has been reduced to fewer than 15 plants per square foot, treatment may be necessary. One available cultural method for control of rice seed midge is to drain fields to reduce numbers of larvae. Re-seeding of heavily infested fields may be necessary. The potential for damaging levels of seed midge can be reduced or prevented by using recommended water and crop management practices. Holding water in rice fields for more than 2 - 3 days before seeding encourages the buildup of large midge numbers before seeding and should be avoided. Practices that encourage rapid seed germination and seedling growth, such as using pre-sprouted seed and avoiding planting in cool weather, will help to speed rice through the vulnerable stage and reduce the chances for serious damage.

Chinch bug, *Blissus leucopterus leucopterus* (Say)
Description and life cycle: Chinch bugs overwinter as adults in grass clumps, leaf litter and other protected areas, emerging in early- to mid-spring to feed and mate on grass hosts including small grains such as wheat, rye, oats and barley. Adults are small, black insects about $^{1}/_{8}$ inch long, with white front wings. Each

wing has a triangular black spot near the outer wing margin. Adults lay white, elongate eggs $^{1}/_{24}$ inch long behind the lower leaf sheaths or in the soil near the roots. Eggs turn red as they mature and larvae emerge in 7 - 10 days. There are 5 nymphal instars. Early instar nymphs are red with a yellow band on the front part of the abdomen. Last instar nymphs are black and gray with a conspicuous white spot on the back. The life cycle from egg to adult takes 30 - 40 days, and adults may live 2 - 3 weeks.

Injury: Chinch bugs are a sporadic pest of rice in the south. Economic injury to rice generally occurs when favorable weather conditions and production practices allow chinch bugs to build in corn, sorghum, and wheat fields. As these crops mature and are harvested, large numbers of chinch bugs may move to young plants in nearby rice fields. Serious economic losses can result from chinch bug infestations if thresholds are reached. The trend toward increasing acreage of small grains increases the potential for chinch bug problems. Chinch bug injury results when adults and nymphs feed on the leaves and stems of rice plants. Feeding on young seedlings causes leaves and stems to turn light brown. High numbers of chinch bugs can kill young plants, severely reducing plant stands.

Scouting and Management: Check unflooded rice near small grain fields every 3 - 5 days from seedling emergence until application of permanent flood. Check foliage in rice fields for chinch bugs. Thresholds for chinch bugs in rice are not available. If high numbers of chinch bugs are present and plant stands are being reduced, the field should be treated. Cultural and chemical control methods are available. Cultural control consists of flooding infested fields to kill chinch bugs or to force them to move onto rice foliage where they can be treated with an insecticide. This tactic requires that levees be in place and that rice plants be sufficiently large to withstand a flood. Cultural control may be more expensive than chemical control.

The Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith)

Description and Life Cycle: The fall armyworm feeds on most grasses found in and around rice fields. It is also a serious pest of corn and pasture grasses. Since rice is not its preferred host, the fall armyworm is only an occasional pest on rice. Adult moths are about 1 inch long with gray-brown sculptured front wings and whitish hind wings. The front wings of male moths have a white bar near the wing tip. This bar is absent in female moths. Females lay masses of 50 to several hundred whitish eggs on the leaves of rice and other grasses in and around rice fields. Egg masses are covered with moth scales and appear fuzzy.

The larvae emerge in 2 - 10 days, depending on temperature, and begin feeding on rice plants. They vary from light green to brown to black, but have distinctive white stripes along the side and back of the body. Larvae feed for two to three weeks, developing through 4 instars. Mature larvae are about 1 inch long and have a distinctive inverted “Y” on the head. Mature larvae prepare a cocoon and pupate in soil or decomposing plant material. Moths emerge in 10 -

15 days, mate and disperse widely before laying eggs on new plants. At least 4 generations per year occur in Louisiana.

Injury: Fall armyworm larvae feed on the leaves of young rice plants, destroying large amounts of tissue. Leaf loss of 25 percent in the seedling stage can reduce rice yields by about 130 pounds per acre. When large numbers of armyworms are present, seedlings can be pruned to the ground, resulting in severe stand loss. Fall armyworm infestations generally occur along field borders, levees and in high areas of fields where larvae escape drowning. The most injurious infestations occur in fields of seedling rice that are too young to flood. Larvae from the first overwintering generation, occurring in early spring, are the most injurious. Infestations later in the season may cause feeding injury to rice panicles, although this is rare.

Scouting and Management: After germination of seedlings, scout fields weekly for larvae on plants. Sample plants every 10 feet along a line across the field, and repeat this process in a second and third area of the field. Treat when there is an average of 1 armyworm per 2 plants. Fall armyworm management consists of cultural, chemical and biological control. Parasitic wasps and pathogenic microorganisms frequently reduce armyworm numbers below economical levels. *Bacillus thuringiensis* var. *kurstaki* under various trade names (**Javelin, Biobit**) can also suppress populations. Since adults lay eggs on grasses in and around rice fields, effective management of grasses can reduce larval infestations. When fall armyworm numbers reach threshold levels, cultural or chemical control is needed. Cultural control consists of flooding infested fields for a few hours to kill fall armyworm larvae. This requires that levees be in place and that rice plants be large enough to withstand a flood. Cultural control may be more expensive than chemical control.

The Rice Leaf Miner, *Hydrelia griseola (Fallen)*

Description and Life Cycle: Adults are dark flies with clear wings and a metallic blue-green to gray thorax. Less than $^1/_4$ inch long, they can be seen flying close to the water and lighting on rice leaves. White eggs are laid singly on rice leaves that float on the water. Transparent or cream-colored legless larvae emerge in 3 - 6 days and begin feeding between the layers of the rice leaf. Larvae become yellow to light green as they feed. Mature larvae are about $^1/_4$ inch long. The larvae feed for 5 - 12 days before pupating. Adults emerge after 5 to 9 days and live 2 - 4 months. Under ideal conditions the life cycle can be completed in as little as 15 days. In cool weather the life cycle can extend for more than 1 month.

Injury: The rice leaf miner is a sporadic problem in Louisiana. Problems are more severe in continuously flooded rice than in periodically flooded rice, and when water is more than 6 inches deep. Injury is usually greatest on the upper side of levees where water is deepest. The rice leaf miner attacks rice during the early spring. Larvae feeding between the layers of the rice leaf cause injury.

Leaves closest to the water are attacked and killed. As larvae move up the plant, additional leaves die. When leaf miner numbers are high, entire plants can die, reducing stands severely. In Louisiana, the rice leaf miner seems to attack fields in the same vicinity year after year.

Scouting and Management: Scout fields for rice leaf miners by walking through flooded rice fields and gently drawing the leaves of rice plants between the thumb and forefinger. Bumps in the leaves indicate the presence of leaf miner larvae or pupae. If leaf miners are present and plant numbers are reduced to less than 15 per square foot, treatment is necessary. Rice leaf miner management involves cultural control or insecticide application, perhaps both. Maintaining water depth at 4 - 6 inches will usually prevent problems with rice leaf miner. If leaf miners are present, lowering the water level in rice fields so that rice leaves can stand up out of the water also will help to prevent injury.

Other Insect Pests of Rice: Several other insects may occasionally attack rice in Louisiana. They include the southern green stink bug, *Nezara viridula* (L.), several grasshopper species, and the larvae of several species of skippers and tiger moths. The numbers of these insects in rice fields are usually below levels justifying treatment, but they may increase rapidly under favorable conditions and yield losses can occur.

RECOMMENDATIONS FOR CONTROL OF INSECTS ON RICE

Insect	Insecticide[1]	Dosage Per Acre (Active Ingredient)	Pre-Harvest Interval	Comments
Aphids	Karate Z[2]	0.025 - 0.04 lb	21 days	Treat when stand is threatened, aphids are present, and natural control is non-sufficient.
	Fury[3]	0.04 - 0.05 lb	14 days	
Armyworms[4]	Methyl parathion 4EC[5]	0.5 - 0.75 lb	15 days	Treat when there is one armyworm per two plants.
	Karate Z[2]	0.025 - 0.04 lb	21 days	
	Fury[3]	0.04 - 0.05 lb	14 days	
Chinch bugs	Icon 6.2 FS[6]	0.025 - 0.05 lb		Seed treatment with Icon for suppression only. Obtain treated seed from authorized seed dealer. Adjust seeding rate based on seed treatment rate to obtain 0.025-0.05 lbs/A.I./acre.
	Karate Z[2]	0.025 - 0.04 lb	21 days	For foliar sprays: Flood fields first.
	Fury[3]	0.033 - 0.05 lb	14 days	
Grasshopper	Methyl parathion 4EC[5]	0.5 lb	15 days	
	Karate Z[2]	0.025 - 0.04 lb	21 days	
	Fury[3]	0.04 - 0.05 lb	14 days	
Rice leaf miners	Methyl parathion 4EC[5]	0.75 lb	15 days	Apply when eggs and larvae are abundant on seedling rice

	Malathion 57% EC[7]	1.56 lb	7 days	and/or when stands are being reduced to less than 15 plants per square foot.
Rice stink bugs	Malathion 57% EC[7] Carbaryl Methyl parathion 4EC[5] Karate Z[2] Fury[3]	0.6 - 0.9 lb 1 - 1.25 lbs (2 - 2.5 pts liquid) 0.5 - 0.75 lb 0.025 - 0.04 lb 0.033 - 0.05 lb	7 days 14 days 15 days 21 days 14 days	Scout in the morning for best results. Treat when there are 30 stink bugs per 100 sweeps during first two weeks of heading. Treat when there are 100 stink bugs per 100 sweeps later until two weeks before harvest.
Rice water weevil (larvae)	Icon 6.2 FS[6]	0.025-0.05 lb		Seed treatment. Obtain treated seed from authorized seed dealer. Adjust seeding rate based on seed treatment rate to obtain 0.025-0.05 lbs/A.I./acre.
Rice water weevil (adults)	Karate Z[2] Fury[3]	0.025-0.04 lb 0.04-0.05 lb	21 days 14 days	Check 10 locations every 3-4 days. Treat when adults are present or fresh feeding scars are observed and when conditions are favorable for egg-laying (i.e. water is present or will be present soon). Scout again beginning 5-7 days after application. More than one application may be necessary.
Rice water weevil (eggs)	Dimilin 2L[8]	0.125-0.25 lb	80 days	A flood is required. Do not apply if flooding is in progress.
Rice seed midges	Icon 6.2 FS[6]	0.025-0.05 lb		Seed treatment (see above). For non Icon-treated fields see footnotes[9]

[1]Insecticides are not listed in order of effectiveness.

[2]Do not use treated rice fields for the aquaculture of edible fish and crustaceans. Do not release floodwater within seven days of application. Do not apply more than 0.12 lb A.I./acre/season. Do not apply as ultra-low volume (ULV) spray.

[3]Do not use treated rice fields for the aquaculture of edible fish and crustaceans. Do not release floodwater within seven days of application. Do not make applications less than seven days apart. Do not apply more than 0.2 lb A.I./acre/season. Do not apply as ULV spray.

[4]Flooding is effective for armyworm control if plants are sufficiently developed.

[5]Do not use methyl parathion within 14 days of applying propanil.

[6]Allow 100-ft buffer between Icon seeded field and crawfish ponds. Do not release floodwater into crawfish ponds. For water-seeded rice, do not release planting flood water prior to 24 hours after seeding. Do not plant leafy vegetables within one month following planting of treated rice seed. Do not plant root crops within five months following planting of treated seed. Do not plant small grains, other than rice, within twelve months after planting treated seed.

[7]Do not use Malathion within 15 days of applying propanil. Applications may not be made around bodies of water where fish or shellfish are grown or harvested commercially.

[8]Do not use treated rice fields for the aquaculture of edible fish and crustaceans. Use at least 5 gallons total volume per acre. Do not disturb flood for at least 7 days after application. Do not release floodwater within 14 days of application.

[9]For non-Icon treated fields: Water management. Check fields for damage during first week after planting. If stands are being reduced significantly (less than 15 plants per square foot), drain and replant if necessary.

WARNING: Always read the label for additional information. Re-entry times for workers entering treated fields should be strictly observed. Be sure to check the label for this information.

RICE INSECT CONTROL IN RICE/CRAWFISH ROTATION FIELDS

Insect	Insecticide[1]	Dosage Per Acre (Active Ingredient)	Pre-Harvest Interval	Comments
Armyworms	*B.t.* (*Bacillus thuringiensis*) [1]	0.5 lb	0	Treat when there is one armyworm per two plants.
Rice leaf miners	Malathion 57% EC[2]	1.56 lb	7 days	Apply when eggs and larvae are abundant on seedling rice and/or when stands are being reduced to less than 15 plants per square foot.
Rice seed midges				Water Management. Check fields for damage during first week after planting. If stands are being reduced significantly (less than 15 plants per square foot), drain and replant if necessary.
Rice stink bugs	Malathion 57% EC[2]	0.6 - 0.9 lb	7 days	Scout in the morning for best results. Treat when there are 30 stink bugs per 100 sweeps during the first two weeks of heading. Treat when there are 100 stink bugs per 100 sweeps later until two weeks before harvest.
Rice water weevil				Water Management. Two to three weeks after permanent flood, sample for rice water weevil larvae. If populations

	are five larvae per core, drain the field and allow the field to dry two to three weeks. (This allows soils to dry to the point of cracking).

[1]There are several formulations on the market. Follow label directions.

[2]Do not use Malathion within 15 days of applying propanil. Applications may not be made around bodies of water where fish or shellfish are grown or harvested commercially.

WARNING: Always read the label for additional information. Re-entry times for workers entering treated fields should be strictly observed. Be sure to check the label for this information.

DISEASES

Introduction

Disease damage to rice can greatly impair productivity and sometimes destroy a crop. The United States does not have any of the destructive viral diseases present in other rice-growing areas of the world, but fungal diseases are prevalent and very destructive to Louisiana rice. Several bacterial diseases have been found, but only one is associated with any significant yield losses. Direct losses to disease include reduction in plant stands, lodging, spotted kernels, fewer and smaller grains per plant, and a general reduction in plant efficiency. Indirect losses include the cost of fungicides used to manage disease, application costs, and reduced yields associated with special cultural practices that reduce disease.

Bacterial Leaf Blight

Bacterial leaf blight is caused by the bacterium *Xanthomonas campestris* pv. *oryzae*. It was first identified in the United States in Texas and Louisiana in 1987. No major losses have been associated with this disease in the United States, but bacterial leaf blight in other parts of the world causes severe damage. The blight bacterium overwinters in rice debris in the soil and on weed hosts. There is also a slight chance that seed may transmit the pathogen. The pathogen is spread by wind-blown rain, irrigation water, plant contact and probably on plant debris adhering to machinery. High humidity and storms favor disease development. Watersoaked areas appear on the leaf margins near the tips, enlarge and turn white to yellow. As the lesions mature, they expand, turn white and then gray because of growing saprophytic fungi. The lesion may be several inches long. Accurate identification is important since the symptoms can be confused with other diseases, especially leaf scald, herbicide damage, and other plant stress. Management practices include rotating to non-grass crops, tilling to destroy plant debris, and avoiding contaminating the field through infected plant materials or irrigation water.

Blast

The fungus *Pyricularia grisea* causes Rice blast. The disease is also called leaf blast, node blast, panicle blast, collar blast, and rotten neck blast; depending on the portion of the plant affected. Blast has been one of the most important diseases in the south, causing considerable yield losses to susceptible varieties under favorable environmental conditions.

Blast can be found on the rice plant from the seedling stage to near maturity. The leaf blast phase occurs between the seedling and late tillering stages. Spots on leaves start as small white, gray, or blue tinged spots. These enlarge quickly under moist conditions to either oval, diamond-shaped spots or linear lesions with pointed ends containing gray or white centers and narrow brown borders. Leaves and whole plants are often killed under severe conditions. Lesions on resistant plants are small brown specks that do not enlarge.

On stem nodes, the host tissue turns black and becomes shriveled and gray as the plant approaches maturity. The infected area may turn dark purple to blue-gray because of the production of fungal spores. Culms and leaves become straw-colored above the infected node. Plants lodge or break off at the infected point, or they are connected only by a few vascular strands. Some varieties are infected where the flag leaf attaches to the sheath at the collar. The lesion turns brown to gray, and the flag leaf becomes detached from the plant as the lesion area becomes dead and dry.

Rotten neck symptoms appear at the base of the panicle starting at the node. The tissue turns brown and shrivels, causing the stem to snap and lodge. If the panicle does not fall off, it may turn white to gray, or the florets that do not fill will turn gray. Panicle branches and stems of florets also have gray-brown lesions.

Scouting a field for blast should begin early in the season during the vegetative phase and continue through the season to heading. Leaf blast will usually appear in the high areas of the field where the flood has been lost or is shallow. Areas of heavy nitrogen fertilization and edges of the fields are also potential sites of infection. If leaf blast is in the field or has been reported in the same general area, and if the variety is susceptible, fungicidal applications are advisable to reduce rotten neck blast development and spread.

The pathogen overwinters as mycelium and spores on infected straw and seed. Spores are produced from specialized mycelium called conidiophores and become windborne at night on dew or rain. The spores are carried by air currents and land on healthy rice plants. The spores germinate under high humidity and dew conditions and infect the plant. Generally lesions will appear four to seven days later, and additional spores are produced. Plants of all ages are susceptible. Medium grain varieties are more susceptible to blast, especially during the leaf phase, than the long grain varieties.

Environmental conditions that favor disease development are long dew periods, high relative humidity, and warm days with cool nights. Agronomic practices that favor disease development include excessive nitrogen levels, late planting and dry soil (loss of flood). Several physiologic races of *P. grisea* exist, and disease development varies, depending on variety-race interactions.

The disease can be reduced by planting resistant varieties, maintaining a 4- to 6-inch flood, proper nitrogen fertilizer, avoiding late planting, and by applying a proper fungicide.

Brown Spot

Brown spot, caused by the fungus *Cochiobolus miyabeanus*, is another prevalent rice disease in the south. When *C. miyabeanus* attacks the plants at emergence, the resulting seedling blight causes sparse or inadequate stands and weakened plants. Leaf spots are present on young rice, but the disease is more prevalent as the plants approach maturity and the leaves begin to senesce. Yield losses from leaf infection or leaf spots are probably not serious. When the fungus attacks the panicle, including the grain, economic losses occur. Heavy leaf spotting indicates an unfavorable growth factor, usually a soil-related problem.

The pathogen also attacks the coleoptiles, leaves, leaf sheath, and branches of the panicle, glumes, and grains. The fungus causes brown, circular to oval spots on the coleoptile leaves of the seedlings. It may cause seedling blight.

Leaf spots are found throughout the season. On young leaves, the spots are smaller than those on older leaves. The spots may vary in size and shape from minute dark spots to large oval and circular spots. The smaller spots are dark brown to reddish-brown. The larger spots have a dark brown margin and a light, reddish-brown or gray center. The spots on the leaf sheath and hulls are similar to those on the leaves.

The fungus attacks the glumes and causes a general black discoloration. It also attacks the immature florets, resulting in no grain development or kernels that are lightweight and chalky.

Brown spot is an indicator of unfavorable growth conditions including insufficient nitrogen, inability of the plants to use nitrogen because of rice water weevil injury, root rot, or other unfavorable soil conditions. As the plants approach maturity, brown spot becomes more prevalent, and the spots are larger on senescing leaves.

Maintaining good growing conditions for rice by proper fertilization, crop rotation, land leveling, proper soil preparation, and water management can reduce damage from brown spot. Seed protectant fungicides reduce the severity of seedling blight caused by this seedborne fungus. Some varieties are less susceptible than others.

Crown Rot

Crown rot is suspected to be caused by a bacterial infection (possibly *Erwinia chrysanthemi)*. It is a minor disease usually associated with a specific variety. Symptoms first appear during tillering. The crown area is decayed, soft-rotting, becoming black or dark brown with discolored streaks extending into the lower internodes of culms. There is a putrid odor characteristic of bacterial soft rots, and tillers start dying one at a time. The roots also die and turn black. Adventitious roots are produced at the node above the crown area. A similar discoloration of the crown can be caused by misapplied herbicides. Control practices are not available.

Crown Sheath Rot

The fungus *Gaeumannomyces graminis* var *graminis* causes crown sheath rot. Other names for this disease include brown sheath rot, Arkansas foot rot, and black sheath rot. It has been considered a minor disease of rice, but recent reports from Texas suggest severe damage can occur. The pathogen kills lower leaves, reduces photosynthetic activity, causes incomplete grain filling, and plants can lodge. Symptoms usually appear late in the season after heading. Sheaths on the lower part of the rice plant are discolored brown to black. Reddish-brown mycelial mats are found on the inside of infected sheaths. Dark perithecia are produced within the outside surface of the sheath. Perithecia are embedded in the sheath tissues with beaks protruding through the epidermis. This disease can easily be confused with stem rot. The fungus survives as perithecia and mycelia in plant residues. Ascospores are windborne in moist conditions. The fungus has been reported to be seedborne. Management practices have not been worked out for this disease.

Downy Mildew

The fungus *Sclerophthora macrospora* causes downy mildew. In early growth stages, infected seedlings are dwarfed and twisted with chlorotic, yellow to whitish spots. Symptoms are more severe on the head. Because of failure to emerge, panicles are distorted, causing irregular, twisted and spiral heads that remain green longer than normal. No management measures are recommended.

False Smut

False smut is caused by the fungus *Ustilaginoidea virens* and is a minor disease of rice grown in the southern region. The disease is characterized by large orange to brown-green fruiting structures on one or more grains of the mature panicle. When the orange covering ruptures, a mass of greenish-black spores is exposed. The grain is replaced by one or more sclerotia. All varieties appear to have a high level of resistance, and disease management measures are not required.

Grain Spotting and Pecky Rice

Many fungi infect developing grain and cause spots and discoloration on the hulls or kernels. Damage by the rice stink bug, *Oebalus pugnax* F., also causes discoloration of the kernel. Kernels discolored by fungal infections or insect damage are commonly called pecky rice. This complex disorder involves many fungi, the white-tip nematode, and insect damage. High winds at the early heading stage may cause similar symptoms. Proper insect control and disease management will reduce this problem.

Kernel Smut

This fungal disease is caused by *Tilletia barclayana*. Symptoms are observed at or shortly before maturity. A black mass of smut spores replaces all or part of the endosperm of the grain. The disease is easily observed in the morning when dew is absorbed by the smut spores. The black spore mass expands and pushes out of the hull. When this spore mass dries, it is powdery and comes off easily with fingers. Rain washes the black spores over adjacent parts of the panicle. Affected grains are a lighter, slightly grayish color compared with normal grain.

Usually only a few florets may be affected in a panicle, but fields have been observed with 20 percent to 40 percent of the florets affected on 10 percent or more of the panicles in a field. Smutted grains produce kernels with black streaks or dark areas. Milled rice has a dull or grayish appearance when smutted grains are present in the sample. Because fewer kernels break when parboiled rice is milled, kernel smut can be a severe problem in processed rice. Growers are docked in price for grain with a high incidence of smut. This disease is usually minor, but it can become epidemic in local areas. Some varieties are more susceptible and should be avoided where smut is a problem. Spores of the fungus are carried on infected seeds and overwinter in the soil of infected fields. The pathogen attacks immature, developing grain and is more severe when rains are frequent during flowering. Specific management measures are not available.

Leaf Scald

This disease, caused by *Gerlachia oryzae*, is common and sometimes severe in Central and South America. It is present in the southern rice area of the United States and in Louisiana annually. It affects leaves, panicles, and seedlings. The pathogen is seedborne and survives between crops on infected seeds. The disease usually occurs on maturing leaves. Lesions start on leaf tips or the edges of leaf blades. The lesions have a chevron pattern of light (tan) and darker reddish-brown areas. The leading edge of the lesion usually is yellow to gold. Fields look yellow or gold. Lesions from the edges of leaf blades have an indistinct, mottled pattern. Affected leaves dry and turn straw-colored. Panicle infestations cause a uniform light to dark, reddish-brown discoloration of entire florets or hulls of developing grain. The disease can cause sterility or abortion of developing kernels. Management measures are not recommended, but foliar fungicides used to manage other diseases have activity against this disease.

Leaf Smut

Leaf smut, caused by the fungus *Entyloma oryzae*, is a widely distributed, but somewhat minor, disease of rice. The fungus produces slightly raised, black spots (sori) on both sides of the leaves and on sheaths and stalks. The blackened spots are about 0.5 - 5.0 mm long and 0.5 - 1.5 mm wide. Many spots can be found on the same leaf, but they remain distinct from each other. Heavily infected leaves turn yellow, and leaf tips die and turn gray. The fungus is spread by airborne spores and overwinters on diseased leaf debris in soil. This disease occurs late in the growing season and causes little or no loss. Control measures are not recommended.

Narrow Brown Leaf Spot

Narrow brown leaf spot, caused by the fungus *Cercospora janseana*, varies in severity from year to year and is more severe as rice plants approach maturity. Leaf spotting may become very severe on the more susceptible varieties causing severe leaf necrosis. Some premature ripening, yield reduction and lodging occur.

Symptoms include short, linear, brown lesions most commonly found on leaf blades. Symptoms also occur on leaf sheaths, pedicels and glumes. Leaf lesions are 2 - 10 mm long and about 1 mm wide, tend to be narrower, shorter and darker brown on resistant varieties and wider and lighter brown with gray necrotic centers on susceptible varieties. On upper leaf sheaths, symptoms are similar to those found on the leaf. On lower sheaths, the symptom is similar to a “net blotch” or Cercospora sheath spot in which cell walls are brown and intracellular areas are tan to yellow.

The primary factors affecting disease development are (1) susceptibility of varieties to one or more prevalent pathogenic races, (2) prevalence of pathogenic races on leading varieties and (3) growth stage. Although rice plants are susceptible at all stages of growth, the plants are more susceptible from panicle emergence to maturity.

Plant breeders have found differences in susceptibility among rice varieties, but resistance is an unreliable control method because new races develop readily. Some fungicides used to reduce other diseases also may have activity against narrow brown leaf spot. Low nitrogen levels favor development of the disease.

Root Knot

Species of the nematode *Meloidogyne* cause root knot. Symptoms include enlargement of the roots and the formation of galls or knots. The swollen female nematode is in the center of this tissue. Plants are dwarfed, yellow and lack vigor. The disease is rare and yield losses low. The nematode becomes inactive after prolonged flooding.

Root Rot

Root rots are caused by several fungi including *Pythium spinosum, P. dissotocum,* other *Pythium* spp., and several other fungi. The rice plant is predisposed to this disorder by a combination of factors including physiological disorders, insect feeding, extreme environmental conditions and various other pathogens.

Symptoms can be noted as early as emergence. Roots show brown to black discoloration and necrosis. As the roots decay, nutrient absorption is disrupted, the leaves turn yellow and the plants lack vigor. With heavy root infections, plants lack support from the roots and lodge, causing harvest problems. Often plants with root rot show severe brown leaf spot infection. The disease is referred to as feeder root necrosis when the small fine roots and root hairs are destroyed. When this happens, no lodging occurs and symptom development is not as apparent on the upper plants.

Fertilizer usually reduces the aboveground symptoms although actual nutrient use is impaired. Rice water weevil control greatly reduces root rots. Draining fields stimulates root growth but can cause problems with blast, weeds, or efficiency of nutrient use.

Seedling Blight

Seedling blight, or damping off, is a disease complex caused by several seedborne and soilborne fungi including species of *Cochiobolus, Curvularia, Sarocladium, Fusarium, Rhizoctonia,* and *Sclerotium*. Typically, the rice seedlings are weakened or killed by the fungi. Environmental conditions are important in disease development. Cold, wet weather is the most detrimental.

Seedling blight causes stands of rice to be spotty, irregular and thin. Fungi enter the young seedlings and either kill or injure them. Blighted seedlings that emerge from the soil die soon after emergence. Those that survive generally lack vigor, are yellow or pale green and do not compete well with healthy seedlings.

Severity and incidence of seedling blight depend on three factors: (1) percentage of the seed infested by seedborne fungi, (2) soil temperature and (3) soil moisture content. Seedling blight is more severe on rice that has been seeded early when the soil is usually cold and damp. The disadvantages of early seeding can be partially overcome by seeding at a shallow depth. Conditions that tend to delay seedling emergence favor seedling blight. Treating the seed with fungicides can reduce some blight fungi that affect rice seedlings at the time of germination.

Seeds that carry blight fungi frequently have spotted or discolored hulls, but seed can be infected and still appear to be clean. *Cochiobolus miyabeanus*, one of the chief causes of seedling blight, is seedborne. A seedling attacked by this fungus has dark areas on the basal parts of the first leaf.

If rice seed is sown early in the season, treating the seed is likely to mean the difference between getting a satisfactory stand and having to plant a second time. Little benefit is received from treating rice seed to be sown late in the season, unless unfavorable weather prevails.

The soilborne seedling blight fungus, *Sclerotium rolfsii*, kills or severely injures large numbers of rice seedlings after they emerge when the weather at emergence is humid and warm. A cottony white mold develops on the lower parts of affected plants. This type of blight can be checked by flooding the land immediately.

Treatment of the seed with a fungicide is recommended to improve or insure stands. Proper cultural methods for rice production, such as proper planting date or shallow seeding of early-planted rice will reduce the damage from seedling blight fungi.

Water- and soil-borne fungi in the genus *Pythium* attack and kill seedlings from germination to about the three-leaf stage of growth. Infected roots are discolored brown or black, and the shoot suddenly dies and turns straw-colored.

This disease is most common in waterseeded rice, and the injury is often more visible after the field is drained. It may also occur in drill-seeded rice during prolonged wet, rainy periods.

Seed treatment, planting when temperatures favor rapid growth of seedlings, and draining the field are the best management measures for seedling disease control.

Sheath Blight

Sheath blight has been the most economically significant disease in Louisiana since the early 1970's. The disease is caused by *Rhizoctonia solani*, a fungal pathogen of both rice and soybeans. On soybeans, it causes the aerial blight disease.

Several factors have contributed to the development of sheath blight from minor to major disease status. They include the increased acreage planted to susceptible long grain varieties, the increase in the acreage of rice grown in rotation with soybeans, the increased use of broadcast seeding and the higher rates of nitrogen fertilizers used with the modern commercial rice varieties. The disease is favored by dense stands with a heavily developed canopy, high temperature and high humidity.

Sheath blight is characterized by large oval spots on the leaf sheaths and irregular spots on leaf blades. Infections usually begin during the late tillering-joint elongation stages of growth. The fungus survives between crops as structures called sclerotia or as hyphae in plant debris. Sclerotia or plant debris floating on the surface of irrigation water serves as sources of inoculum that attack and infect lower sheaths of rice plants at the waterline. Lesions about

0.5 - 1 cm in width and 1 - 3 cm in length are formed a little above the waterline on infected culms. Fungus mycelium grows up the leaf sheath, forms infection structures, infects, and causes new lesions. The infection can spread to leaf blades. The lower leaf sheaths and blades are affected during the jointing stages of growth. After the panicle emerges from the boot, the disease progresses rapidly to the flag leaf on susceptible varieties. With very susceptible varieties, the fungus will spread into the culm from early sheath infections. Infected culms are weakened, and the tillers may lodge or collapse.

The fungus can spread in the field by growing from tiller to tiller on an infected plant or across the surface of the water to adjacent plants. The fungus also grows across touching plant parts, for example from leaf to leaf, causing infections on nearby plants. Infected plants are usually found in a circular pattern in the field because the fungus does not produce spores and must grow from plant to plant.

The lesions have grayish-white or light green centers with a brown or reddish-brown margin. As lesions coalesce on the sheath, the blades turn yellow-orange and eventually die. As areas in the field with dead tillers and plants increase, they may coalesce with other affected areas to cause large areas of lodged, dead and dying plants. Damage is usually most common where wind-blown, floating debris accumulates in the corners of cuts when seedbeds are prepared in the water.

Sheath blight also affects many grasses and weeds other than rice causing similar symptoms. Sclerotia that survive between crops are formed on the surface of lesions on these weed grasses, as well as on rice and soybeans. The sclerotia are tightly woven masses of fungal mycelium covered by an impervious, hydrophobic coating secreted by the fungus.

Integrating several management practices can reduce disease severity. Dense stands and excessive use of fertilizer both tend to increase the damage caused by this disease. Broadcast seeding tends to increase stand and canopy density. Rotation with soybeans or continuous rice increases the amount of inoculum in field soils. Fallow periods, with disking to control growth of grass weeds, will reduce inoculum in the soil. The pathogen also is known to infect sorghum, corn and sugarcane when environmental conditions are favorable for disease development.

Medium grain rice varieties are more resistant to sheath blight than most of the long grain varieties. Several recently released long grain varieties are more resistant to sheath blight than the older long grain varieties. Fungicides are available for reducing sheath blight.

Sheath Rot

This disease is caused by the fungal pathogen *Sarocladium oryzae*. Symptoms are most severe on the uppermost leaf sheaths that enclose the young panicle during the boot stage. Lesions are oblong or irregular oval spots with gray or light brown centers and a dark reddish-brown, diffuse margin. The lesions may form an irregular target pattern. On U.S. rice varieties, the lesion is usually expressed as a reddish-brown discoloration of the flag leaf sheath. Early or severe infections affect the panicle so that it only partially emerges. The unemerged portion of the panicle rots, turning florets red-brown to dark brown. Grains from damaged panicles are discolored reddish-brown to dark brown and may not fill. A powdery white growth consisting of spores and hyphae of the pathogen may be observed on the inside of affected sheaths. Insect or mite damage to the boot or leaf sheaths increases the damage from this disease.

This disease affects most rice varieties. The disease is usually minor, affecting scattered tillers in a field. Occasionally, larger areas of a field may have significant damage. Control measures are not recommended. Fungicidal sprays used in a general disease management program reduce damage, but recent studies show that several bacterial pathogens commonly cause similar sheath rot symptoms on rice. Fungicides would have little to no effect on these pathogens.

Sheath Spot

The fungus *Rhizoctonia oryzae* causes this disease. The disease resembles sheath blight, but is usually less severe. The lesions produced by *R. oryzae* are found on sheaths midway up the tiller or on leaf blades. Lesions are oval, 0.5 - 2 cm long and 0.5 - 1 cm wide. The center is pale green, cream or white with a broad, dark reddish-brown margin. Lesions are separated on the sheath or blade and do not form the large, continuous lesions often found with sheath blight. The pathogen attacks and weakens the culm under the sheath lesion on very susceptible varieties. The weakened culm lodges or breaks over at the point where it was infected. Lodging caused by sheath spot usually occurs midway up the culm.

This disease is usually minor on southern rice. Some fungicides used to manage sheath blight also reduce sheath spot.

Stackburn

This disease was first observed on rice growing in Louisiana and Texas. Stackburn or Alternaria leaf spot is caused by the fungal pathogen *Alternaria padwickii*. It is now common on rice around the world.

The disease is present in all rice fields in Louisiana. Only occasional spots are observed, but the disease may be more severe in restricted areas of a field. The spots are typically large (0.5 - 1 cm in diameter), oval or circular, with a dark brown margin or ring around the spot. The center of the spot is initially tan and eventually becomes white or nearly white. Mature spots have small dark or black dots in the center. These are sclerotia of the fungus. Grain or seeds affected by the disease have tan to white spots with a wide, dark brown border. The disease causes discoloration of kernels, or the kernels stop development and grains are shriveled.

No specific control recommendations are available, but seed-protectant fungicides will help reduce the seedling blight caused by this pathogen and will reduce the number of spores available to cause leaf infections.

Stem Rot

Stem rot caused by the fungus *Sclerotium oryzae* is an important disease in Louisiana. Often, losses are not detected until late in the season when it is too late to initiate control practices. Stem rot causes severe lodging, which reduces combine efficiency, increases seed sterility, and reduces grain filling.

The first symptoms are irregular black angular lesions on leaf sheaths at or near the water line on plants at tillering or later stages of growth. At later stages of disease development, the outer sheath may die, and the fungus penetrates to the inner sheaths and culm. These become discolored and have black or dark brown lesions. The dark brown or black streaks have raised areas of dark fungal mycelium on the surface and gray mycelium inside the culm and rotted tissues. At maturity, the softened culm breaks, infected plants lodge and many small, round, black sclerotia develop in the dead tissues.

The pathogen overwinters as sclerotia in the top 2 - 4 inches of soil and on plant debris. During water-working and establishment of early floods, the hydrophobic sclerotia float on the surface of the water and often accumulate along the edge of the field and on levees due to wind.

After a permanent flood is established, the sclerotia float to the surface, contact the plant, germinate and infect the tissues near the waterline. The fungus then penetrates the inner sheaths and culm, often killing the tissues. The fungus continues to develop, forming many sclerotia in the stubble after harvest.

Most commercial varieties of rice are not highly resistant to stem rot. The disease is favored by high nitrogen levels. Early maturing varieties are usually less affected by stem rot. In addition, applications of potassium fertilizer reduce disease severity in soils where potassium is deficient. Stem rot is more serious in fields that have been in continuous rice production for several years.

Suggested management measures include using early maturing varieties, avoiding very susceptible varieties, and burning stubble. Cultivation after harvest can destroy sclerotia. Using crop rotation when possible, applying potassium fertilizer, avoiding excessive nitrogen rates, and applying foliar fungicides also aid in control. Several cultural practices may reduce stem rot. These include fluctuating the water level in the field so stagnant water does not remain at the same level on the lower leaf sheaths, and draining water from the field at the tillering and early jointing stages of growth, while keeping the soil saturated. However, caution is advised as these practices may lead to the development of leaf blast and other problems.

Water-Mold and Seed-Rot

With the extensive use of the waterseeding method of planting rice, it has become more difficult to obtain uniform stands of sufficient density to obtain maximum yields. The most important biological factor contributing to this situation is the water-mold or seed-rot disease caused primarily by fungi in the genera *Achlya* and *Pythium*. Recently, certain *Fusarium* spp. also have been found associated with molded seeds. The disease is caused by a complex of these fungi infecting seeds. The severity of this disease is more pronounced when water temperatures are low or unusually high. Low water temperatures slow the germination and growth of rice seedlings but do not affect growth of these pathogens.

In addition to the direct cost of the lost seeds and the cost of replanting, watermold also causes indirect losses caused by the reduced competitiveness of rice with weeds in sparse or irregular stands. Also, replanting or overseeding the field causes the rice to mature late when conditions are less favorable for high yields because of unfavorable weather and high disease pressure.

Water mold can be observed through clear water as a ball of fungal strands surrounding seeds on the soil surface. After the seeding flood is removed, seeds on the soil surface are typically surrounded by a mass of fungal strands radiating out over the soil surface from the affected seeds. The result is a circular copper-brown or dark green spot about the size of a dime with a rotted seed in the center. The color is caused by bacteria and green algae, which are mixed with the fungal hyphae.

Achlya spp. normally attacks the endosperm of germinating seeds, destroying the food source for the growing embryo and eventually attacking the embryo. *Pythium* spp. usually attacks the developing embryo directly. When the seed is affected by the disease, the endosperm becomes liquefied and oozes out as a white, thick liquid when the seed is mashed. The embryo initially turns yellow-brown and finally dark brown. If affected seeds germinate, the seedling shoot and root are attacked and the seedling is stunted. When infection by *Pythium* spp. takes place after the seedling is established, the plant is stunted, turns yellow and grows poorly. If the weather is favorable for plant growth, seedlings often outgrow the disease and are not severely damaged.

The disease is less severe when rice is water-seeded when weather conditions favor seedling growth. High and low temperatures averaging above 65° F favor seedling growth, and water mold is less severe. Seeds should be vigorous and have a high germination percentage. Seed with poor vigor will be damaged by water-mold fungi when water-seeded.

Treat seed with a recommended fungicide at the proper rate to reduce water molds and seed diseases. Most rice seed is treated by the seedsman and is available to the grower already treated. Seed-protectant fungicides differ in their effectiveness.

White Tip

This disease is caused by the nematode *Aphelenchoides besseyi*. Characteristic symptoms which appear after tillering include the yellowing of leaf tips, white areas in portions of the leaf blade, stunting of affected plants, twisting or distortion of the flag leaf, and distortion and discoloration of panicles and florets. Leaf tips change from green to yellow and eventually white. The tip withers above the white area, becoming brown or tan and tattered or twisted. Resistant varieties may show few symptoms and still have yield loss.

The nematode infects the developing grain and is seedborne.

This disease is considered minor. Fumigation of seeds in storage will reduce the nematode population. No other specific control measures are recommended.

Chemical Disease Control Guidelines:

Moncut 70 DF (flutolanil) Apply 0.5 - 0.71 lb. a.i./A by air in 5 - 10 gpa to control sheath blight. Apply at first internode elongation, and follow with a second application at the same rate 10 - 14 days later. Use the higher rate where disease pressure is expected to be heavy. In fields where close scouting is practiced to detect and monitor sheath blight, apply 0.5 - 1.0 lb. a.i./A when 5 - 10% of the tillers of a susceptible variety or 10 - 15% of the tillers of a moderately susceptible variety have blight lesions. Continue scouting and reapply if disease begins to move up the rice stem again.

- Do not apply more than 1.43 lb. a.i./A per given year.
- Do not apply later than 30 days prior to harvest, or beyond 75% heading development stage, whichever comes first.
- This pesticide is toxic to shrimp. Do not apply within 3 miles of any estuarine/marine waterways or watershed.
- Flooded fields may be used for aquaculture of crayfish only following rice harvest.
- Do not enter treated fields for 12 hours after application

Quadris 2F (azoxystrobin) Apply 0.15 - 0.20 lb. a.i./A by ground, air (5 - 10 gpa), or chemigation. For panicle blast on rice not grown in rotation with another crop, apply no more than 2 sequential applications of Quadris over multiple years before alternating to a fungicide with a different mode of action. For stem/sheath diseases including stem rot, black sheath rot, and sheath spot, apply when disease is less than 4 inches above water line usually between panicle differentiation (PD) +5 days to PD +10 days or at initial sign of disease. Under heavy disease pressure, a second application may be applied. For foliar and panicle diseases, apply as a preventative treatment prior to disease development. For panicle blast, an application should be made at mid-boot to boot-split but prior to full head emergence. A second application should be made when panicles are 60 - 90% emerged from the boot (7 - 14 days later).

- Do not treat rice fields used for aquaculture of fish and crustaceans.
- Do not apply when weather conditions favor drift. Use care when making applications near non-target aquatic habitats.
- Do not apply more than 0.6 lb. ai/A per season.
- Do not apply within 28 days of harvest.

- Do not allow release of irrigation or floodwater for at least 14 days after last application.
- Do not apply more than 2 applications of Quadris or other strobiluron fungicide per season.
- Do not enter treated fields for 4 hours after application.

Tilt (propiconazole) When applied by air in 5 - 10 gpa, Tilt controls sheath blight, brown leaf spot, narrow brown leaf spot, brown blotch, leaf smut, sheath spot, and black sheath rot. It can suppress stem rot. Apply on either of the following schedules:

A. 6 fl. oz./A at first internode elongation (up to 2-inch panicle) and repeat at swollen boot. Make the second application 10-14 days after the first application but before the boot splits and head emerges. Tilt provides best control of sheath blight when the first application is applied at disease appearance in the field. The first application is recommended when 5% or fewer of the tillers are infected.

B. 10 fl. oz./A at first internode elongation (up to 2-inch panicle). The 10 oz. rate is recommended if greater than 10% of the tillers are infected with sheath blight. If disease reappears, use another registered fungicide for the second application.

- Do not apply to stubble or ratoon crop rice.
- Do not use in rice fields where commercial farming of crayfish will be practiced.
- Do not drain water from treated rice fields into ponds used for commercial catfish farming.
- Do not use water drained from treated fields to irrigate other crops.
- Unless soil-injected or soil-incorporated, do not enter treated fields for 24 hours after application.

Apron XL LS (mefenoxam) Apply as a seed treatment at 0.0425 - .085 fl. oz./cwt of seed to control *Pythium* seed rot and damping off. Apron can be used in conjunction with ***Vitavax CT.*** Follow label directions closely when mixing seed treatments. Unless soil-injected or soil-incorporated, do not enter treated fields for 48 hours after application.

Vitavax CT (carboxin) Apply as a seed treatment at 9 - 12 fl. oz./cwt of seed to control *Rhizoctonia solani* and *Helminthosporium oryzae.* Vitavax CT is toxic to fish. Do not apply directly to water.

PHYSIOLOGICAL DISORDERS

Cold Injury

Cold weather affects rice development most at the seedling or reproductive stages of growth. Seedling damage is expressed as a general yellowing of the plants or as yellow or white bands across the leaves where a combination of wind and low temperature damaged the plants at the soil line. Cold weather (less than 60° F) present during the reproductive stages causes panicle blanking or blighting. Individual florets or the whole panicle may be white when emerging. To eliminate this problem, adjust planting date to avoid low temperatures.

Panicle Blight

Panicle blight or grain blight was recently identified as being caused by the bacterium *Burkholderia glumae.* The bacterium is seedborne and can cause a seedling blight that can thin stands significantly. The bacterial population appears to follow the growing plant as an epiphytic population on the foliage. This population infects the grain at flowering and causes grain abortion and grain rotting soon after pollination. Yield loss estimates vary from a trace to 50 percent yield and quality losses.

Initial symptoms of grain infection appear as a gray discoloration of the glumes. Infected grains can be unevenly distributed on the panicle. In severe infections, all of the seed can be damaged. Diagnosis is difficult because of other causes of seed infection and sterility producing similar symptoms and masking panicle blight symptoms after lesion maturity. A key diagnostic characteristic is the stem staying green up to the seed.

High temperatures favor the disease. It usually develops in a circular pattern in the field with severely affected plants in the center and less affected plants around the edge. Infected heads can be confused with straighthead because of their upright stature. No parrot beaks are present. Some varieties are less susceptible than others. Chemical control measures are being developed. Seed treatments have shown some activity in reducing seedborne pathogen populations and subsequent head severity.

Salinity

Soil alkalinity, or salinity, and water salinity injure rice and are characterized by areas of stunted, chlorotic plants in the field. Under severe conditions, leaves turn from yellow to white, and plants die. Affected areas usually have dead or dying plants in the center or on high spots, with stunted yellow or white plants surrounding that area and green, less affected plants in lower areas. Salt deposits may be seen on the edges of leaves, on clods of soil and other high areas of the field. Flushing with water low in salt reduces damage.

Straighthead

Straighthead is a physiological disorder associated with sandy soils, fields with arsenic residues or fields having large amounts of plant residue incorporated into the soil before flooding. Panicles are upright at maturity because the grain does not fill or panicles do not emerge from the flag leaf sheath. Hulls (palea and lemma) may be distorted and discolored, with portions missing or reduced in size. Distorted florets with a hook on the end are called "parrot beak" and are typical of straighthead. Plants are darker green or blue-green and often produce new shoots and adventitious roots from the lower nodes. These symptoms can be mimicked by herbicide damage. Manage by using resistant varieties and draining at the first internode elongating stage of growth to dry the soil until it cracks. Do not plant susceptible varieties under conditions favorable for straighthead development, which include very sandy soils, soils with high levels of undecomposed plant residue or fields with a history of arsenical herbicide (such as MSMA) applications.

WEEDS

Introduction

Weeds compete with rice for water, nutrients, space and light. Direct losses from weed competition are measurable and can be great. Indirect losses such as increased costs of harvesting and drying, reduced quality and dockage at the mill, and reduced harvest efficiency are not readily measured but can reduce profits. Numerous grasses, broadleaf weeds and sedges can be economically damaging in rice. Weeds can grow and thrive in aquatic or semiaquatic environments common to rice culture. Barnyardgrass, broadleaf signalgrass, red rice, hemp sesbania, alligatorweed, dayflower, ducksalad, redstem, jointvetch, and annual and perennial sedges are among the most common weeds. Although weeds vary in their ability to compete with rice, most fields contain a complex of weeds which will reduce yield and quality if an appropriate weed management strategy is not implemented.

Rice weed control is best accomplished by using a combination of cultural, mechanical and chemical control practices. Relying on a single control practice seldom provides adequate weed control. A thorough knowledge of the weeds present in each field is critical in developing appropriate management strategies.

Cultural Control

Purchasing seed rice that is weed free is an important first step in preventing weeds from becoming established, especially in the case of red rice. Red rice has been spread largely by planting commercial seed that is contaminated. Red rice is a wild rice that is similar to commercial rice. Besides reducing commercial rice yields, the red pericarp of this noxious rice can contaminate milled rice. Additional milling can help remove the red discoloration but often will lead to reduced head rice yields through breakage of kernels. Cooking attributes of rice can be altered if significant amounts of red rice are present in milled rice. Newer selective herbicide management strategies for red rice will be discussed later in the weed management section.

Presence of red rice dictates production systems and weed control options and decreases flexibility. Rotating rice with other crops can reduce future weed problems. Successful rotations with soybeans primarily and to a lesser extent with corn, sorghum, soybeans or cotton have reduced levels of red rice in later rice crops.

Proper water management is a key component in controlling weeds. Several different water management schemes have evolved. Permanent flood and pinpoint flood cultures were developed in water-seeded rice to reduce weed problems. These practices attempt to maintain a saturated seedbed. Saturated seedbeds prevent weed seeds from germinating because of the absence of oxygen.

Establishing a good stand of rice and providing an environment that promotes rapid growth also help to minimize weed interference. Optimum plant populations and adequate fertility, insect, disease and water management contribute to the ability of rice plants to compete with weeds.

Management of weeds is critical for optimum rice production in both water and dry-seeded systems. Although herbicide options and management strategies differ under these systems, managing herbicides and water in a timely manner is critical.

Water-seeded rice

Weed populations shift from terrestrial weeds in dry-seeded systems to aquatic weeds in water-seeded systems. Red stem, ducksalad, alligatorweed and rushes are prevalent in water-seeded systems. Grasses such as barnyardgrass and broadleaf signalgrass as well as some warm-season perennial grasses (e.g., water bermuda) in some areas can be a problem also.

In water-seeded systems, Bolero or Ordram are applied before seeding to suppress aquatic weeds and grasses. After seedling establishment, propanil, Arrosolo and Facet are used to control grasses and broadleaf weeds. These herbicides are often supplemented with Basagran to control ducksalad and red stem. The field is generally drained briefly to expose weeds to herbicides. When doing so, it is important that the soil remain wet in fields where red rice is present. Allowing the soil to dry can result in reinfestation by red rice.

Granular Ordram also controls grasses and can be applied directly in the floodwater. Londax has become a standard for use in water-seeded rice to control ducksalad and other difficult-to-control aquatic weeds. Applying Londax at the appropriate timing is critical to control. Londax is applied into the flood-water before aquatic weeds have surfaced, and a stationary flood must be maintained for seven days for acceptable control. Some dealers offer fertilizer materials impregnated with Londax, an effective application that reduces cost.

Several herbicides are available for post-flood weed control in both water- and dry-seeded systems. Facet, Blazer, Basagran, Grandstand, Londax and 2,4-D are registered for use. Selection of these herbicides should be based on the spectrum of weeds and restrictions on use. For example, 2,4-D use is prohibited where rice is grown in close proximity to cotton and other 2,4-D-sensitive crops. Although registered for use, apply Whip 360 only in salvage situations when other herbicides have failed to control grass weeds. Excessive rice injury can occur. Precautions on variety selection and cultural practices that may contribute to injury should be considered before use.

Problem weed species

barnyardgrass - A warm-season vigorous grass reaching up to 5 feet, barnyardgrass (*Echinochloa crus-galli*) has panicles that may vary from reddish to dark purple. The seed heads contain crowded large seeds in spikelets, each with a short, stiff awn. Leaf blades are flat, $^{3}/_{8}$ to $^{5}/_{8}$ inch wide, smooth, and without a ligule, a papery-like membrane at the collar of the plant where the leaf blade contacts the stem. The stem is flat—not round.

red rice - Red rice is so closely related genetically to commercial rice that anything that will control red rice will generally kill the crop. In fact, it's the same species—*Oryza sativa*. Red rice plants vary considerably. The tall-growing, black-hulled, awned plant is easiest to recognize and is considered by many to be a typical red rice plant. However, other strains have developed that have straw-colored hulls, are awnless and are about the same height as desirable rice varieties.

alligatorweed - Alligatorweed (*Alternanthera philoxeroides*) is an aquatic perennial that forms dense floating mats. It has hollow stems, opposite leaves with distinctive midribs and a single white flower head. The leaves are elliptically shaped and $^{1}/_{4}$ to $^{3}/_{4}$ inch wide.

hemp sesbania - Commonly called coffeebean or coffeeweed, hemp sesbania (*Sesbania exaltata*) is a tall, blue-green, spindly weed growing up to 12-14 feet. The plants have a yellow, pea-like flower. Seed pods are 4-8 inches long, curved and often tipped with a $^{1}/_{2}$ -inch-long beak. The leaves are opposite and may feature as many as 70 leaflets with a smooth surface and somewhat hairy surface below.

broadleaf signalgrass - A spreading summer annual, broadleaf signalgrass (*Brachiaria platyphylla*) has short, wide leaf blades, ranging from $1^{1}/_{2}$ to 6 inches long and $^{1}/_{4}$ to $^{2}/_{3}$ inch wide. Leaf blades are typically hairless, except for hairs that occur in the margins and the lower portion of young plants. It doesn't have a ligule, a papery-like membrane at the junction of the sheath and leaf blade.

ducksalad - An aquatic annual or perennial, ducksalad (*Heteranthera limosa*) grows in open water either near water inlets or in openings in sparse stands. The mature plant grows up to 6 inches tall. Leaf blades may either narrow to a point or be duckbilled at the tip.

redstem - An erect, simple or freely branched annual, redstem (*Ammannia coccinea*) grows to $1^1/_2$ tall, the branches ascending, or basal branches, when present, spreading.

jointvetch - Two different species may infest rice fields: Indian jointvetch (*Aeschynomene indica*) and northern jointvetch (Aeschynomene virginica). Both are upright and usually bushy, growing up to 3-4 feet tall. Indian jointvetch differs from northern jointvetch in that its fruit stalk and leaflets are shorter and its flower smaller. Northern jointvetch plants have large stipules or bracts at the base of the leaf stalk or petiole. Both have pea-like flowers and can be distinguished from hemp sesbania because of a smaller size and more delicate appearance. The alternating leaves have as many as 56 oblong leaflets with smooth edges. Leaflets fold when touched.

dayflower - A crawling, spreading summer annual, dayflower (*Commelina communis*) grow up to 2 feet. The plant may grow either upright or creeping with numerous branches sprouting at the nodes and stems. Leaves have conspicuous sheaths at the base, and flowers feature two upright blue petals and one smaller white petal. The egg-shaped leaves are $^1/_3$ to $^1/_2$ inch long and $^1/_3$ to $1^1/_2$ inches wide.

yellow nutsedge - Also called yellow nutgrass, yellow nutsedge (*Cyperus esculentus*) is an aggressive plant that grows between 3 and 32 inches and has adapted to water culture. Distinctive features include a yellow umbrella-like seed head and smooth three-ranked leaves that gradually taper to a small point. Fibrous roots grow from bulbs, rhizomes or tubers. Stems are triangular and rarely branch from the tuber or basal bulb.

morningglories (*Ipomoea sp.*), annual, climbing vine reaching over 6 feet. Introduced native of tropical America. Chordate and lobed-shaped leaves depending upon species.

Texas weed - Although also referred to as Mexicanweed (Caperonia castanifolia), Texasweed (*Caperonia palustrus*) is a different species. The annual upright plant grows to about 2-3 feet tall with coarse male and female flowers with unique three-capsuled fruit. Leaves are alternating and broad, with serrated edges.

smartweeds (*Polygonum sp.*), erect, summer annual with some species reaching 6 feet. Leaf blades ovate-lanceolate to lanceolate. Stems with swollen nodes.

eclipta - A spindly growing annual weed, Eclipta (*Eclipta prostrata*) has simple opposite leaves. Leaves measure 3-5 inches long and are elliptical, lacking stalks. Lower surfaces of leaves are hairy. Stems feel sand papery.

sprangletop - Three species of sprangletop may infest rice fields—Mexican sprangletop (*Leptochloa uninervia*), bearded sprangletop (Leptochloa fasciculais) and red sprangletop (Leptochloa filifomis). All three are tall with thin, flat leaf blades, running $^1/_4$ to $^1/_3$ inch wide and up to 12 inches long. Sprangletop has a ligule, a papery-like membrane at the collar of the plant where the leaf blade contacts the stem. All three have a large, open panicle when mature.

Dry-seeded production

In this system, four to six weeks may elapse between planting and permanent flood establishment, and controlling weeds during this period is critical for maximizing yields. During this period barnyardgrass, broadleaf signalgrass, sprangletop, morningglories, texasweed, eclipta, jointvetch, smartweeds and hemp sesbania can become established. Timely herbicide applications made to small weeds, flushes to activate herbicides, and establishment and maintenance of a permanent flood as soon as possible will improve weed control.

The residual herbicides Prowl, Facet and Bolero can provide residual weed control up to permanent flood establishment, and these herbicides have proven valuable in dry-seeded production. They are especially beneficial when delays in permanent flood establishment are anticipated or on clay soils where cracking of soil promotes numerous weed flushes as well as difficulty in establishing and maintaining a permanent flood. Although these herbicides do not always provide complete control, when applied in a program with propanil or Arrosolo, these herbicides generally provide adequate control up to permanent flood establishment. These herbicides, and in particular Facet, are more effective when fields are flushed or when adequate rainfall occurs for activation.

Propanil, Arrosolo and Facet are used routinely to control emerged weeds before flood establishment. Propanil is a contact herbicide with no residual activity. Arrosolo contains both propanil and molinate, and it provides contact and limited residual weed control. Facet controls emerged weeds, but, unlike propanil and Arrosolo, root absorption of Facet is important. Flushing or adequate rainfall shortly after application of Facet is needed for activation regardless of whether or not weeds have emerged. Combinations of contact herbicides such as propanil and Arrosolo with the residual herbicides like Facet, Bolero or Prowl are often more effective than single herbicide applications. Weeds that are not under moisture stress and are actively growing are controlled more easily than stressed weeds.

Grandstand, Londax, Basagran, Storm and Blazer can be applied preflood in dryseeded systems. Propanil, Arrosolo and Facet are generally needed for grass control, and these broadleaf herbicides are used to broaden the spectrum of control. Grandstand controls morningglories, jointvetch and alligatorweed.

Londax and Basagran are used to control sedges and certain broadleaf and aquatic weeds.

Herbicide programs should be developed based on the complex of weeds present in each field. Scouting fields and accurately identifying weeds are critical in formulating herbicide programs. For example, Facet provides excellent control of barnyardgrass but does not control sprangletop. Relying on Facet alone for weed control will result in sprangletop escapes which can compete with rice. An additional herbicide application will be needed to control sprangle-top, and the delay in application caused by misidentification can make sprangletop more difficult to control. Annual sedges can often be controlled with propanil or Arrosolo, but these herbicides seldom control yellow nutsedge adequately when applied alone; Basagran or Londax is generally needed.

In dry-seeded systems, pulling levees as soon as possible after planting can improve weed control by allowing fields to be flushed and flooded in a timely manner. Without levees, using water as a management tool is impossible. On coarse-textured, silt loam soils, pulling levees is much easier than on finer-textured, clay soils. Although rainfall shortly after planting is beneficial for establishing a rice stand and reducing the need for flushing, excessive rainfall can prevent levee construction on clay soils. Pulling levees as soon as the rice is planted when the soil is still relatively dry can prevent or reduce problems in preparing levees on wet soils.

Adjuvants and Spray Additives

Postemergence herbicide performance can be greatly influenced by adjuvants. Grandstand, Londax, Basagran, Facet and the dry formulations of propanil must be applied with a suitable adjuvant to control emerged weeds. Gramoxone Extra and Harmony Extra applied as burndown treatments require adjuvants. In contrast to these herbicides, adjuvants will not improve control with emulsifiable propanil, Arrosolo or Whip 360. Bolero, Facet (preemergence or delayed preemergence), Prowl or Ordram applied to the soil before weed emergence does not require adjuvants. When a liquid propanil formulation or Arrosolo is applied with Grandstand, Londax, Facet or Basagran, additives are not needed. When Facet or dry formulations of propanil are mixed with these predominantly broadleaf herbicides, however, an adjuvant should be included.

Adjuvant cost is much lower than the cost of a herbicide application, especially when several herbicides are applied as a mixture. Not using an adjuvant or selecting a poor quality adjuvant can reduce weed control greatly. Consult the herbicide label for recommendations of the type of adjuvant (crop oil concentrate, nonionic surfactant, etc.) and the proper rate to use.

Reduced-tillage and stale seedbed systems

Producing rice in stale seedbed, reduced-tillage or no-till systems requires use of burndown herbicides applied before seeding in water-seeded systems and before rice emergence in dry-seeded systems. Timing of application will depend on the spectrum and size of weeds, anticipated planting date and label restrictions. The key is to have a weed free seedbed when the rice emerges (dryseeded rice) or when the flood is established in water-seeded systems. A problem associated with no-till, waterseeded rice is poor water quality and low oxygen resulting from decaying plant residue. Timely vegetation management can minimize this situation. Roundup Ultra, Gramoxone Extra, 2,4-D and Harmony Extra are registered for use in rice. Applying combinations of Roundup Ultra with 2,4-D or Harmony Extra increases control of some broadleaf weed species and may broaden the spectrum of control. Each of these has strengths and weaknesses, and herbicide programs should be tailored to control the existing weed spectrum. Gramoxone Extra has the advantage of rapid kill of weeds and requires only a two-day period before the flood can be established for seeding in water-seeded systems. This is an advantage in controlling red rice.

These herbicides also have restrictions on preplant intervals which can potentially limit utility. For example, Harmony Extra cannot be applied within 45 days of planting. Additionally, various formulations of 2,4-D are available, and labels vary on rates and preplant intervals. Applying Roundup and Gramoxone Extra with residual herbicides such as Bolero, Prowl and Facet can improve early-season weed control. Bolero can be applied in dry- and water-seeded systems, and Prowl can be applied only as a delayed preemergence application in dry-seeded systems. Facet can be applied preemergence or delayed preemergence in dry-seeded systems. It is critical to establish a weed-free seedbed for the emerging rice in dry- and waterseeded systems. When weeds are not controlled and rice has emerged, control can be difficult with in-season herbicides for most winter annual and perennial weeds. Also, summer annual weeds that are not controlled before rice emergence will be older, larger and often harder to control with propanil or other rice herbicides.

Weed Resistance

Some weeds have developed resistance to herbicides. In situations where weeds are not controlled with labeled rates of herbicides applied under environmental conditions which are favorable for herbicide activity, these weeds may be resistant. Repeated use of propanil has resulted in development of biotypes throughout the Mid-South that can no longer be controlled with propanil. Aquatic weeds in California have developed resistance to Londax. Rotating herbicides and crops, and applying tank mixtures consisting of herbicides with different mechanisms of action, may prevent or delay development of resistance in Louisiana. For example, mixtures of propanil with Facet, Bolero or Prowl include at least two different mechanisms of action and reduce selection pressure. Rotating rice with soybeans or other crops will allow use of soil-applied herbicides or postemergence grass herbicides which can control barnyardgrass and red rice. These herbicides have mechanisms of action that differ from most rice herbicides.

If weed resistance is suspected, contact your county agent so an alternative herbicide program can be developed and resistance can be monitored. In addition to developing potential weed resistance, repeated use of a single herbicide will exploit the weakness of the herbicide and may shift the weed spectrum to weeds that may be more difficult to control. This has been especially true in continued use of Facet only, which has resulted in a shift from barnyardgrass as the primary grass weed to sprangletop.

Red Rice Management

Because red rice and commercial rice are so closely related genetically, herbicides that control red rice will generally kill commercial rice. Water management alone can often effectively suppress red rice and reduce competition. Red Rice is a growing problem throughout the three-state growing region. However, this weed is a larger problem in south-central and southern Louisiana. Predicting its spread is difficult. Presence of red rice mandates that rice be produced in a water-seeded system, preferably the pinpoint production system. Uniform, level seedbeds are critical for success. Presoaked seed is preferred because it gives the commercial rice an additional advantage over the red rice. Before flying on the rice seed, the field is tilled to muddy the water and kill germinated red rice that would otherwise emerge through clear water. This type of tillage can be difficult on clay soils. Depending on environmental conditions, the flood is removed and rice seedlings are allowed to peg into the soil. An advantage of presoaked seed is that the flood can be removed sooner than with dry rice. This can reduce the time seeds are exposed to wind and drift within bays and can help lead to a more uniform stand. After rice seedlings have anchored, the flood is brought up slowly until the permanent flood is established. Maintenance of flooded soil conditions reduces emergence of red rice and other weeds. Water management in this system is critical, and breakdowns in control usually result from inadequate flood maintenance.

Although Bolero and Ordram suppress red rice, they do not provide complete control. Using these herbicides in combination with water management, however, can minimize interference from red rice. Rotating rice with soybeans or other crops and controlling red rice with effective herbicides are important in managing red rice.

Recently, Newpath (imazethapyr) selectivity has become a tool to use in the management of red rice and annual grasses. Newpath can only be applied to Clearfield (imidazolinone-tolerant) rice varieties that have been dry seeded or drill planted.

Summary

Numerous herbicides and tank mixtures of herbicides are available for use in rice, and, with the exception of red rice, adequate weed control can be obtained when these herbicides are applied in a timely manner coupled with appropriate water management. Early season weed interference can be very detrimental and can reduce yields even though control practices are implemented later. Failure to apply herbicides in a timely manner may result in poor weed control and the need for repeat applications. These situations allow more early-season weed competition and generally less effective control.

Before using a herbicide, follow all directions and precautions. In addition to being illegal, failure to follow the label can result in poor weed control, excessive rice injury and environmental and safety hazards.

Chemical Weed Control Guidelines

Preplant Burndown

Roundup (glyphosate) Apply 0.5 - 1.5 lb. a.i./A to control actively growing weeds. Apply at least 7 days before flood establishment in water-seeded systems and prior to rice emergence in dry-seeded systems. Requires 7 to 21 days to kill most weeds. Applying with 2,4-D or Harmony Extra may broaden the spectrum of control. Do not enter treated fields for 4 hours after application.

Gramoxone Extra (paraquat) Apply 0.5 - 1.5 lb. a.i./A to control emerged annual weeds. May defoliate perennial weeds but will not kill them. Apply at least 2 days before flood establishment in water-seeded systems and prior to rice emergence in dry seeded systems. Add surfactant at 0.25% - 0.5% on a volume basis. Do not enter treated fields for 12 hours after application.

2,4-D (various trade names) Apply 0.5 - 1.0 lb. a.i./A to control emerged broadleaf weeds. Apply at least 2 weeks before planting or flood establishment depending upon the formulation. Add surfactant at 0.25% - 0.5% on a volume basis. Do not enter treated fields for 12 hours after application.

Harmony Extra (thifensulfuron+tribenuron) Apply 0.015 - 0.023 lb. a.i./A for emerged broadleaf weeds. Apply at least 45 days before planting. Add surfactant at 0.25% on a volume basis. Do not enter treated fields for 12 hours after application.

Roundup + Harmony Extra (glyphosate + thifensulfuron+tribenuron) Apply 0.5 - 1.5 + 0.015 - 0.023 lb. a.i./A for improved control of curly dock, cutleaf evening primrose, and smartweed. Apply at least 45 days before planting. Add surfactant at 0.25% on a volume basis. Do not enter treated fields for 12 hours after application.

Roundup + 2,4-D (glyphosate+various trade names) Apply 0.5 - 1.5 + 0.5 - 1.0 lb. a.i./A for improved control of curly dock and cutleaf evening primrose. Apply at least 2 weeks before planting depending upon the formulation. Add surfactant at 0.25% - 0.5% on a volume basis. Do not enter treated fields for 12 hours after application.

Gramoxone Extra + Harmony Extra (paraquat + thifensulfuron+tribenuron) Apply 0.5 - 1.5 + 0.015 - 0.023 lb. a.i./A for improved control of curly dock, cutleaf evening primrose, and smartweed. Apply at least 45 days before planting. Add surfactant at 0.25% - 0.5% on a volume basis. Do not enter treated fields for 12 hours after application.

Gramoxone Extra + 2,4-D (paraquat + various trade names) Apply 0.5 - 1.5 + 0.5 - 1.0 lb. a.i./A for improved control of curly dock and cutleaf evening primrose. Apply at least 2 weeks before planting depending upon the formulation. Add surfactant at 0.25% - 0.5% on a volume basis. Do not enter treated fields for 12 hours after application.

Preplant Incorporated

Ordram 15G (molinate) Apply 3.0 - 4.0 lb. a.i./A to control barnyardgrass, annual sedges, and suppression of red rice and large crabgrass. Incorporate in water-seeded rice on all soils and dry-seeded rice on finer textured/clay soils. Apply immediately prior to flood establishment in water-seeded rice. Loss due to volatilization may occur if not incorporated. Can also be applied by air into floodwater in water-seeded systems. Do not apply where sensitive varieties are grown. Do not enter treated fields for 12 hours after application.

Preplant Surface-applied

Bolero 8EC (thiobencarb) Apply 4.0 lb. a.i./A to control barnyardgrass, annual sedges, and partial control of red rice. Apply after final seedbed preparation immediately before flood establish in water-seeded rice. Water-seed rice early. Avoid losing flood as water management is critical. Do not apply to sensitive varieties. Do not enter treated fields for 4 hours after application.

Preemergence (Dry seeded)

Facet 75WP (quinclorac) Apply 0.33 lb. a.i./A (sandy soil), 0.5 lb. a.i./A (loamy soil), or 0.67 lb. a.i./A (clay soil) to control barnyardgrass, morningglory, hemp sesbania, and northern jointvetch. Facet does will not control sprangletop, smartweed, or nutsedge. Apply after planting but before emergence. Make sure seed are covered with soil. Adequate rainfall or flushing is needed for activation. If soil dries, flush for reactivation. Has longer residual control than Bolero. Avoid drift to susceptible crops. Do not enter treated fields for 12 hours after application.

Delayed Preemergence (Dry seeded)

Bolero 8EC (thiobencarb) Apply 4.0 lb. a.i./A to control sprangletop, barnyard-grass, and aquatic weeds. Will not control emerged weeds or broadleaf signalgrass. Apply 1 - 5 days before rice emerges. Adequate rainfall or flushing is needed for activation. If soil dries, flush for reactivation. Control will generally not exceed 3 weeks. Injury may occur if rice is stressed. Do not enter treated fields for 4 hours after application.

Facet 75WP (quinclorac) 0.25 - 0.5 lb. a.i./A See comments above. Delayed preemergence application may provide greater residual control relative to flood establishment. Add 1 pt/A crop oil concentrate if weeds have emerged. Do not enter treated fields for 12 hours after application.

Facet 75WP + Bolero 8EC (quinclorac + thiobencarb) 0.25 - 0.5 + 3.0 - 4.0 lb. a.i./A. See comments above. Will broaden spectrum of control relative to the individual herbicides listed above. Do not enter treated fields for 12 hours after application.

Prowl 3.3EC (pendimethalin) Apply 0.75 - 1.0 lb. a.i./A to control sprangletop, barnyardgrass, broadleaf signalgrass, and crabgrass. Use low rates for coarse textured soil and high rates for fine textured soil. Apply 1 - 5 days before rice emerges. Do not apply preplant incorporated or immediately after planting. Rice seed must have imbibed water before application. Apply only after rainfall or flushing for germination. Do not enter treated fields for 24 hours after application.

Facet 75WP + Prowl 3.3EC (quinclorac + pendimethalin) 0.25 - 0.5 + 0.75 - 1.0 lb. a.i./A. See comments above. Will broaden spectrum of control relative to the individual herbicides listed above. Do not enter treated fields for 24 hours after application.

Early Postemergence

Propanil (various trade names) Apply 3.0 - 4.0 lb. a.i./A to control barnyardgrass, fall panicum, broadleaf signalgrass, hemp sesbania, northern jointvetch, rushes, and annual sedges. Can be used in dry- or water-seeded rice, but foliage must be exposed. Better control on small weeds with less than 4 leaves. Does not have residual activity, so repeat applications may be necessary. Add 1 qt/A to dry propanil formulations. Applying propanil with Facet, Bolero, or Prowl will improve grass control. Avoid drift to susceptible crops. NOTE: Some populations of barnyardgrass have developed resistance to propanil at rates as high as 30 lb/A. Facet, Bolero, and Prowl can control these populations when applied in a timely manner with appropriate water management. Do not enter treated fields for 24 hours after application.

Arrosolo (propanil + molinate) Apply 2.25 - 3.0 + 2.25 - 3.0 lb. a.i./A to control barnyardgrass, fall panicum, broadleaf signalgrass, hemp sesbania, northern jointvetch, rushes, and annual sedge. Apply to emerged weeds. Do not apply to rice that is not rooted in water-seeded systems. Provides better control than propanil if environmental conditions are marginal (moisture stress and low temperatures). Gives some residual weed control. Do not apply to Millie or Adair. Do not enter treated fields for 24 hours after application.

Propanil or Arrosolo + Londax (propanil or propanil+molinate + bensulfuron-methyl) Apply 3 - 4 or 4.5 - 6.0 + 0.028 - 0.38 lb. a.i./A to control annual grasses, yellow nutsedge, annual sedges, morningglories, hemp sesbania, northern jointvetch, redstem, eclipta, and texasweed. Apply 1 - 7 days prior to establishment of permanent flood. Weed must be exposed to herbicide. Use caution with susceptible varieties. Application to rice with exposed roots may be injured in water-seeded systems. Do not enter treated fields for 24 hours after application.

Postemergence (Contact and residual control)

Propanil + Bolero 8EC (propanil + thiobencarb) Apply 3 - 4 + 3 lb. a.i./A to control barnyardgrass, sprangletop, broadleaf signalgrass, fall panicum, hemp sesbania, northern jointvetch, rushes, annual sedges, and aquatic weeds. If rice is water-seeded, apply only after rice is well rooted and in the 2-leaf stage. Drain flood or surface water from field before application. Application to rice stressed by high salt and/or high pH soils may cause excessive rice injury. Rainfall or flushing will be needed for activation if soil begins to crack. Provides up to 3 weeks residual control. Do not enter treated fields for 24 hours after application.

Propanil + Prowl 3.3EC (propanil + pendimethalin) Application rates are 3 - 4 + 0.75 - 1.0 lb. a.i./A. See comments under propanil + thiobencarb. Apply to emerged weeds not covered by water. Drain flood or any surface water before application. Rainfall or flushing will be needed for activation. Gives 2-week residual control. Residual control from Prowl may be reduced after flooding, flushing, or several days of heavy rainfall. If used on water-seeded rice, do not apply before the 3 - 4 leaf stage. Do not enter treated fields for 24 hours after application.

Facet 75WP + Propanil (quinclorac + propanil) Apply 0.25 - 0.38 + 3 - 4 lb. a.i./A to control barnyardgrass, broadleaf signalgrass, morningglories, hemp sesbania, northern jointvetch, rushes, and annual sedges. See rate recommendations above for Facet relative to soil type. Apply to small actively growing weeds. Add crop oil concentrate at 1 qt/A if dry propanil formulation is used. Rainfall or flushing may be required for activation or deactivation. Do not enter treated fields for 24 hours after application.

Facet 75WP (quinclorac) 0.25 - 0.5 lb. a.i./A See previous comments above concerning Facet especially when pertaining to rates relative to soil type. Add 1 qt/A crop oil concentrate. Apply to small actively growing weeds. Seed exposed to the spray may be injured. Add propanil if weeds exceed 1-inch height. Rainfall or flushing may be required for activation or reactivation. Fields treated with Facet should be scouted for smartweed, nutsedge, and sprangletop and treated if necessary. Do not enter treated fields for 12 hours after application.

Early Postemergence (Specialty use)

Propanil + Basagran (propanil + bentazon) Apply 3.0 - 5.0 + 0.75 lb. a.i./A to control annual grasses, smartweed, cocklebur, redstem, yellow nutsedge, dayflower, and spike rush. Will not control purple nutsedge. Apply to small annual grasses, broadleaf and aquatic weeds and nutsedge. Propanil timing for grasses should be applied as for propanil alone. Add 1 qt/A crop oil concentrate if dry propanil formulation is used. For use in dry- or water-seeded rice. Gives no residual control. Control of yellow nutsedge can be erratic. Do not enter treated fields for 48 hours after application.

Propanil + Blazer (propanil + acifluorfen) Apply 3.0 - 4.0 + 0.125 - 0.25 lb. a.i./A to control annual grasses, morningglories, and hemp sesbania. Apply when hemp sesbania is 1 - 5 feet tall and morningglory runners are less than a foot long. May cause tip burn on rice but injury usually does not last. Gives no residual control. Do not apply more than 1 pt/A of Blazer per season. The addition of Blazer can reduce propanil activity on grasses. Apply to small actively growing weeds. For use in dry- or water-seeded rice. Do not enter treated fields for 48 hours after application.

Propanil + Storm (propanil + bentazon+acifluorfen) Apply 3 - 5 + 0.5 + 0.25 lb. a.i./A to control barnyardgrass, cocklebur, hemp sesbania, morningglories, redstem, smartweed, and eclipta. Apply to small actively growing weeds. Gives no residual control. For use in dry- or water-seeded rice. Storm may reduce propanil activity on grasses. Do not enter treated fields for 48 hours after application.

Grandstand (triclopyr) Apply 0.25 - 0.38 lb. a.i./A to control northern jointvetch, hemp sesbania, morningglories, and alligatorweed. Apply to small actively growing weeds. Can be applied when rice has 3 - 4 leaves up until $^{1}/_{2}$ inch internode elongation. Do not enter treated fields for 48 hours after application.

Grandstand + Propanil or Arrosolo (triclopyr + propanil or propanil+molinate) Apply 0.25 - 0.38 + 3.0 - 4.0 or 2.25 - 3.0 + 2.25 - 3.0 lb. a.i./A to provide better control than either of the herbicides alone. Do not include adjuvants with liquid formulations of propanil or Arrosolo. Include crop oil concentrate with dry formulations of propanil. Refer to labels for susceptible varieties. Do not enter treated fields for 48 hours after application.

Ordram 15G (molinate) Apply 3.0 - 5.0 lb. a.i./A to control barnyardgrass, dayflower, sprangletop, annual sedge, and suppression of spike rush. Apply to barnyard-grass 3 - 24 inches or sprangletop 8 inches or less. Apply to flooded field and maintain flood until grass is controlled. The smaller the grass or the longer the flood on the longer grass, the better the suppression. Do not apply to sensitive varieties. Do not enter treated fields for 12 hours after application.

Londax (bensulfuron-methyl) Apply 0.038 - 0.0625 lb. a.i./A to control ducksalad, redstem, eclipta, false pimpernel, gooseweed, dayflower, flatsedge, water hyssop, and arrowhead. Apply within 5 days after flooding and maintain flood at least 7 days. For water-seeded rice, apply as soon as possible after rice has pegged and flood has stabilized. Avoid pumping for 7 days after treatment, if possible. If weeds have emerged, add 1 qt/A crop oil concentrate. Do not enter treated fields for 24 hours.

Permit (halosulfuron-methyl) Apply 0.5 - 1.0 lb. a.i./A to control annual and perennial sedges, hemp sesbania, and jointvetch. Does not control grassy weeds. The label prohibits post-flood application. Permit may be tank mixed with other postemergence herbicides to broaden weed control spectrum. Do not enter treated fields for 12 hours after application.

Whip (fenoxaprop-p-ethyl) Apply 0.059 - 0.067 lb. a.i./A to control grassy weeds such as sprangletop and barnyardgrass. Water management is critical, and performance is dependent upon environmental conditions. Can injure sensitive varieties. Do not enter treated fields for 24 hours.

Postemergence (Broadleaf and aquatic weed control at midseason)

2,4-D (various trade names) Apply 1 - 1.5 lb. a.i./A of 2,4-D to control broadleaf and aquatic weeds. Apply between the first internode elongation (first green ring) and $^{1}/_{2}$ inch long internode elongation (second green ring). Do not apply when internode exceeds $^{1}/_{2}$ inch. Adhere to restrictions on 2,4-D application in north Louisiana. Adhere to individual label specifications for pre-harvest restrictions and restricted entry intervals.

Grandstand (triclopyr) 0.25 - 0.38 lb. a.i./A of triclopyr to control broadleaf and aquatic weeds. Does not control ducksalad. Triclopyr may be applied from the 3- to 4-leaf stage up to $^{1}/_{2}$ inch long internode elongation. Apply within 2 weeks of harvest. Do not enter treated fields for 48 hours after application.

Blazer (acifluorofen) Apply 0.125 - 0.25 lb. a.i./A to control hemp sesbania at 1 - 5 feet. Do not apply past the boot stage of rice. May cause tip burn on rice, but symptoms are quickly outgrown. Do not apply within 45 days of harvest. Do not enter treated areas for 48 hours.

Preharvest

Sodium Chlorate (various trade names) Apply 6 lb. a.i./A for the desiccation of green weed foliage when average moisture is 25% or below. Harvest within 7 days after application to prevent overdrying. Do not enter treated areas for 12 hours.

Ratoon Crop

Hi-Dep 2,4-D Apply 0.47 - 0.95 lb. a.i./A to control most broadleaf weeds. Apply within 2 weeks of first harvest. A shallow flood should be present at time of application. Do not enter treated fields for 48 hours after application.

Grandstand (triclopyr) Apply 0.38 lb. a.i./A to control northern jointvetch, hemp sesbania, and other broadleaf weeds. Does not control ducksalad. Apply within 2 weeks of harvest. Do not enter treated fields for 48 hours after application.

Basagran (bentazon) Apply 1.0 lb. a.i./A to control sedges and some broadleaf weeds. Apply to small weeds less than 8- to 10-inches tall. Do not enter treated fields for 48 hours after application.

Newer Herbicides

Newpath (imazethapyr) Apply 0.0625 lb. a.i./A for excellent control of red rice, grassy weeds, and nutsedge. Gives fair control for a short list of broadleaf and aquatic weeds but is weak on hemp sesbania and jointvetch. For complete control of red rice, two applications are required. Newpath must be applied preplant incorporated or preemergence and postemergence prior to permanent flood only to Clearfield (imidazolinone-tolerant) varieties. Postemergence applications require nonionic surfactant at 0.25% on a volume basis. Application timing and water management are critical. Adequate soil moisture is required for optimum herbicide activation for all methods of soil application. Newpath must be applied pre-flood when rice is in the three- to five-leaf growth stage. Permanent flood should be initiated within two days after postemergence applications. There should be an interval of at least 45 days between Newpath application and harvest. Do not enter treated fields for 12 hours after application.

Command (clomazone) Apply 0.4 - 0.6 lb. a.i./A preemergence to early-postemergence for annual grass control. Application window is 1-2 leaf rice. Rate depends on soil type with higher rates used on heavier soils. Do not use post-flood. Not recommended for coarse soils. Small and medium grain rice is more susceptible to injury. Observe label for rotational and application restrictions. Do not enter treated fields for 12 hours after application.

Ricestar (fenoxaprop-p-ethyl) Apply 13 - 17 fl. oz. per acre before tillering stage of rice to control annual grassy weeds such as barnyardgrass, fall panicum, and sprangletop. It does not control broadleaf weeds. Do not use surfactant. ***Ricestar*** is essentially ***Whip*** with a safener. Ricestar can be used post-flood. Observe label for rotational and application restrictions. Do not enter treated fields for 24 hours after application.

Regiment (bispyribac sodium) Apply 11.25 - 15 g product/A postemergence for most broadleaf weeds and barnyardgrass after the 3-leaf stage of rice. Regiment has demonstrated good activity on rice flatsedge and hemp sesbania at low use rates. However, it is weak on broadleaf signalgrass and sprangletop. Regiment can be applied post-flood. Do not enter treated fields for 12 hours after application.

VERTEBRATE PESTS

Blackbird Management

Blackbirds (Icterinae) are among the most numerous birds in rice-growing areas. The red-winged blackbird *(Agelaius phoeniceus)* is the most abundant breeding bird in the rice-growing area of southwestern Louisiana. Red-winged blackbirds are responsible for most rice depredation. Brown-headed cowbirds *(Molothrus ater)*, common grackles *(Quiscalus quiscula)* and boat-tailed grackles *(Quiscalus major)* cause the rest of rice damage. Blackbirds can be responsible for significant economic loss during sprouting and ripening stages each year. Damage to sprouting rice can be particularly severe in water-seeded rice. Economic losses caused by blackbird damage are most severe in fields located within five miles of winter roost sites. These areas are traditionally adjacent to coastal marshes.

Both federal and state governments recognize that blackbirds are important depredators of agricultural commodities. Blackbirds are migratory birds and are provided protection under provisions of the Migratory Bird Treaty Act. They may be controlled without a federal permit when found depredating agriculture crops.

No conventional agricultural pesticides are labeled for use in reducing blackbird damage in rice production. No lethal chemical compound that will control blackbirds in agricultural crops safely and effectively is likely to be registered for general use by producers in the near future. Methods of control involve alternative cultural practices, scare devices, chemical repellents and restricted use toxicants.

Cultural Practices

1) Drill seed rice on a well-prepared seedbed. Water-plant only where a continuous uniform flood of 2 - 6 inches can be kept on the rice.

2) Delay planting rice in high blackbird infested areas (such as coastal areas) until after April 1. Arrange planting programs so fields near roost areas or coastal marshes are planted last. Begin planting nearest the farm headquarters and progress to more sensitive areas later in the season.

3) Block planting in areas of traditionally severe bird damage, such as in fields adjacent to coastal marshes, can be effective in reducing damage on individual farms. This method requires that a group of farmers in a given area plant all or most of their rice on, or near, the same date.

4) Consider alternate crops in high bird pressure areas where there has been a history of extreme damage to rice crops.

5) Habitat modification and clean cropping may be helpful in reducing the number of resident blackbirds damaging rice crops at maturity. Removing brush and trees from ditch banks, levees, fence rows and keeping fields free of weeds will eliminate blackbird habitat in and around field areas.

Scare Devices

Propane exploders with timers to turn them off and on automatically each day are the most effective scare devices used to move feeding blackbirds from freshly planted rice fields and after maturity. There should be a least one exploder for every 25 acres of crop to be protected. They should be elevated on a barrel, stand or truck bed to “shoot” over the crop. They should be moved around the field every few days. Exploders should be reinforced with live ammunition fired from shotgun and .22 caliber rifles. In addition, pyrotechnics such as 12-gage shell crackers, rope fire crackers and rocket bombs can be helpful when used with live ammunition and propane exploders.

Chemical Repellents

1) Chemical repellents are compounds that must be registered by EPA. When placed on rice seed or other bait, repellents will deter consumption of newly planted seed by blackbirds. They work by causing olfactory, gustatory, or digestive irritation in the target animal. At present, no chemical repellents are registered to protect newly planted rice seed.

2) Methyl anthranilate under the trade name of Bird Shield™ is a chemical compound that holds promise for protecting seed rice.

Restricted Use Toxicants

1) Avitrol (4-aminopyridine) is a poison with flock-alarming properties used to control blackbirds and starlings in, on or around the area of feedlots, structures, nesting, roosting and feeding sites. It acts in such a way that only a part of the flock feeding on the bait will ingest treated bait, react and frighten the rest away. Birds that react and alarm a flock usually die. Avitrol is for sale to and use only by certified applicators or persons under their direct supervision and only for those uses covered by the Certified Applicators Certification. Distribution of Avitrol should be limited to scattered spot placements that will provide feeding opportunities only for the necessary number of target birds. After the birds' feeding pattern has been established through prebaiting, untreated bait is removed and diluted treated bait applied only at sites where the target birds are actively feeding. Do not apply this product where non-target bird species are feeding. Treated bait should be picked up and removed from the field each day.

2) Compound DRC-1339 is an avicide registered for use in parts of the southern region under a 24 (C), local needs label. Only personnel of the USDA Animal Damage Control Program and those working under their supervision can use it. DRC-1339 is applied to brown rice baits broadcast on blackbird staging areas near winter and spring roosting sites. Depending on the number of birds killed, the product is sometimes effective in reducing rice depredations associated with large concentrations of roosting blackbirds. DRC-1339 has not been effective when used in areas where blackbirds are widely dispersed.

Lesser Vertebrate Pests

Occasionally other vertebrate pests invest some rice fields. Among these are feral hogs, nutria, and beavers. The damage is usually not direct but interferes with other cultural practices involved in growing the crop. Several of these pests, as in the case of nutria and beavers, interfere with water management by damaging ditch banks and levees. Beaver dams around drains can cause fields to flood excessively. Damage by feral hogs is more direct, and in isolated cases, severe. In rare but extreme cases these animals must be removed by either trapping, or in the case of feral hogs, hunting.

POST HARVEST PESTS

Insects

Many types of insects attack small grains in storage. Because small grains are usually harvested in late spring and early summer and stored when temperatures are high, insects can develop rapidly within the grain. Therefore, insect problems in storage are more severe in small grains than in other grains, such as corn, that are harvested and stored during cooler fall and winter months. If a problem occurs, the first step is to identify the insect pest. Producers not familiar with stored-grain pests should consult their county extension agent for assistance.

Primary Feeders

Weevils

The rice weevil (*Sitophilus oryzae*) is about $^1/_8$ inch long and are reddish brown to almost black. The wing covers are usually marked with four reddish or yellow spots. Eggs are laid within individual kernels, and the grub-like larvae consume the grain from within. Pupation occurs in the kernel, and adults leave through a small round hole, leaving behind a hollow kernel. During warm weather, an entire generation may be completed within 26 days; thus, stored grain may be severely damaged within a month of harvesting. Infestations may start near the top of a storage bin (as a result of insects that fly in from outside) or near the bottom (caused by insects that migrate up through the perforated floor). Weevils are very mobile and may be found anywhere within the grain mass.

Lesser Grain Borer

Adult and larval stages of the lesser grain borer (*Rhyzopertha* dominica) feed on and within kernels. The beetles have a slender, cylindrical form, with the head turned under the body. They are dark brown or black and are slightly less than $^1/_8$ inch long. Eggs are laid in the grain. After they hatch, the young larvae feed upon debris or flour produced by the boring beetles. In a short period, larvae bore into the kernels and feed from within. Lesser grain borer populations can build up rapidly in warm weather and can cause significant losses. The beetles can develop throughout the grain mass and cause weevil-like damage.

Grain Moths

Indian meal moths and Angoumois grain moths usually feed on the exposed surface of the stored grain mass. They rarely penetrate more than 1 foot beyond or below the surface. Therefore, their damage potential is somewhat limited. However, damage and contamination from these insects can cause an economic loss.

The Angoumois grain moth (*Sitotroga cerealella*) is a small, buff-colored or yellowish brown moth with a wing span of about $^1/_2$ inch. Infestation may occur in the field or within bins. Under normal circumstances, eggs are laid on the outside of the grain and the larvae bore into and develop within the grain. The larvae are small, white caterpillars with yellowish heads and grow to $^{1}/_{4}$ inch long. An important identification characteristic of this insect is the small round emergence hole the adult produces as it leaves each infested kernel.

Indian meal moth (*Plodia interpunctella*) caterpillars feed from the outside of the kernel and primarily destroy the germ. They also feed on dust, chaff, and broken kernels. Thus, they are more of a threat to seed grain than grain intended for feeding purposes. The moths have a wing span of about $^{3}/_{4}$ inch with reddish brown to copper-colored markings on the outer $^{2}/_{3}$ of the front wings. Larvae are dirty white, about $^{1}/_{2}$ inch long, and may produce a great deal of webbing. They stay on the surface of the grain and do not develop deep within the grain mass. Severe infestations are covered with large amounts of surface webbing that may clog unloading and grain-handling equipment.

Secondary Feeders

The saw-toothed grain beetle (*Oryzaephilus surinamensis*) adult is a small, active, brown beetle, $^{1}/_{8}$ inch long, with a flattened body and six saw-toothed projections on each side of the thorax. The larva is yellowish-white, about $^{1}/_{8}$ inch long, with a brown head. The abdomen tapers toward the tip.

The flat grain beetle (*Cryptolestes pusillus*) is about $^{1}/_{16}$ inch long and is one of the smallest beetles commonly found in stored products. It has a greatly flattened body with antennae about $^{2}/_{3}$ as long as the body. Both larvae and adults have chewing mouthparts.

Management

Pre-storage Procedures

Insect management for stored grain depends upon good sanitation and grain storage practices. Clean grain-handling equipment before harvest. Clean nearby feed storage areas, feed rooms, and similar areas to reduce the potential for insect migration into the new, non-infested grain.

Before harvest, thoroughly clean inside, around and under the empty bin. Although it may be difficult and time-consuming to remove and clean under the perforated floor, most insect problems originate in carryover material from this area. The floor should be periodically taken up, if possible. Spray the bin walls, roof, and floor to the point of runoff with Tempo, Reldan 4E, or Malathion. Be sure to treat cracks, crevices around doors and behind false partitions, and similar voids.

Reldan 4E (Chlorpyrifos-methyl) – 8 oz. per 6.5 gallons of water using 1 gallon finished spray per 650 sq. ft. to 1250 sq. ft.

Tempo (Cyfluthrin) – Mix 0.05% solution and spray 1 gallon per 1000 sq. ft.

Malathion (various) – 1 gallon of a 57% EC in 25 gallons of water.

Protecting Stored Grain

Apply liquid grain protectants to the grain as it is being augured into the bin to ensure adequate coverage. Reldan at 9 oz. per 5 gallons water per 1000 bushels is a popular approved grain protectant. *Bacillus thuringiensis (Bt)* (consult label) should be applied to control Indianmeal moths.

Inspect the grain at monthly intervals (weekly when the temperature is greater than 60^o F). Use probes and appropriate equipment to monitor temperature, moisture, and insect presence at several sites and depths. Even when outdoor temperatures are low, moisture, insects and sunlight may produce areas within the grain mass that are warm enough to allow insect development. Therefore, be sure to inspect the grain frequently and thoroughly.

Fumigation

Aluminum phosphide (Phostoxin, Fumitoxin, etc., check labels) is best in most circumstances for fumigation of infested grain. Five days in a very tightly sealed storage are normally required for aluminum phosphide fumigation, depending on temperature.

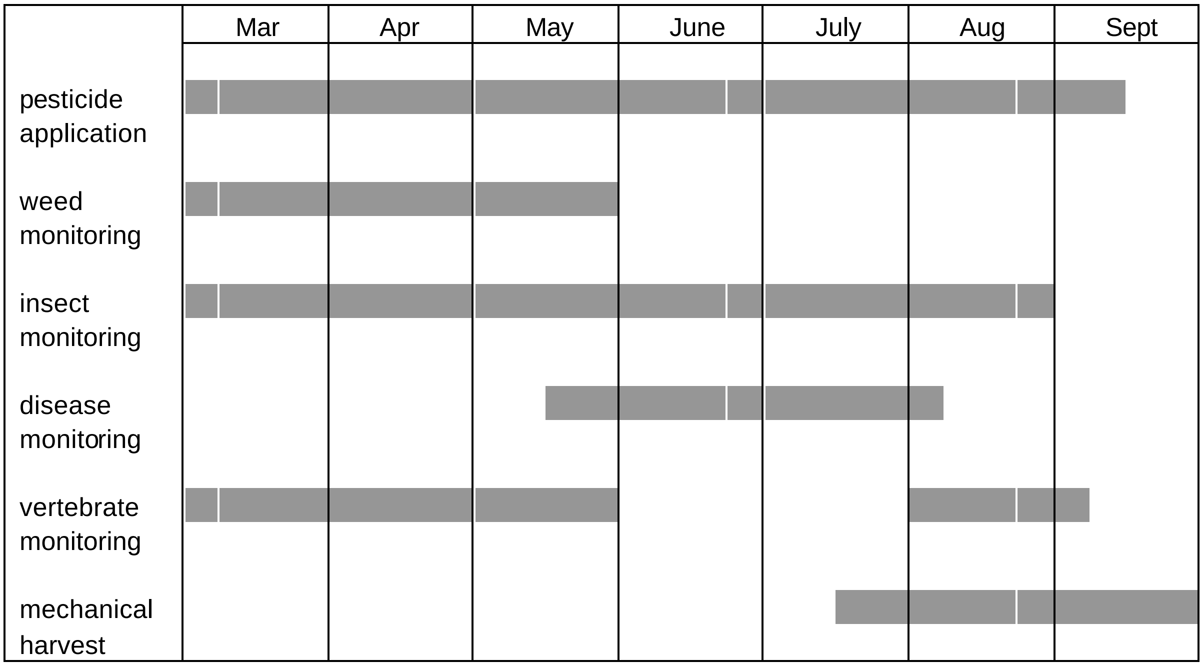
Fumigation is tricky and potentially dangerous. It should be done professionally unless the producer knows how to do it right, has the equipment to do it properly, and is properly certified. Careless or uninformed fumigation can result in death.

Diseases

Certain diseases caused by fungi occurring in the field may be carried over upon storage and processing. These are controlled by drying the rice at harvest and maintaining proper moisture content in the bins.

TIMELINES

Worker Activities



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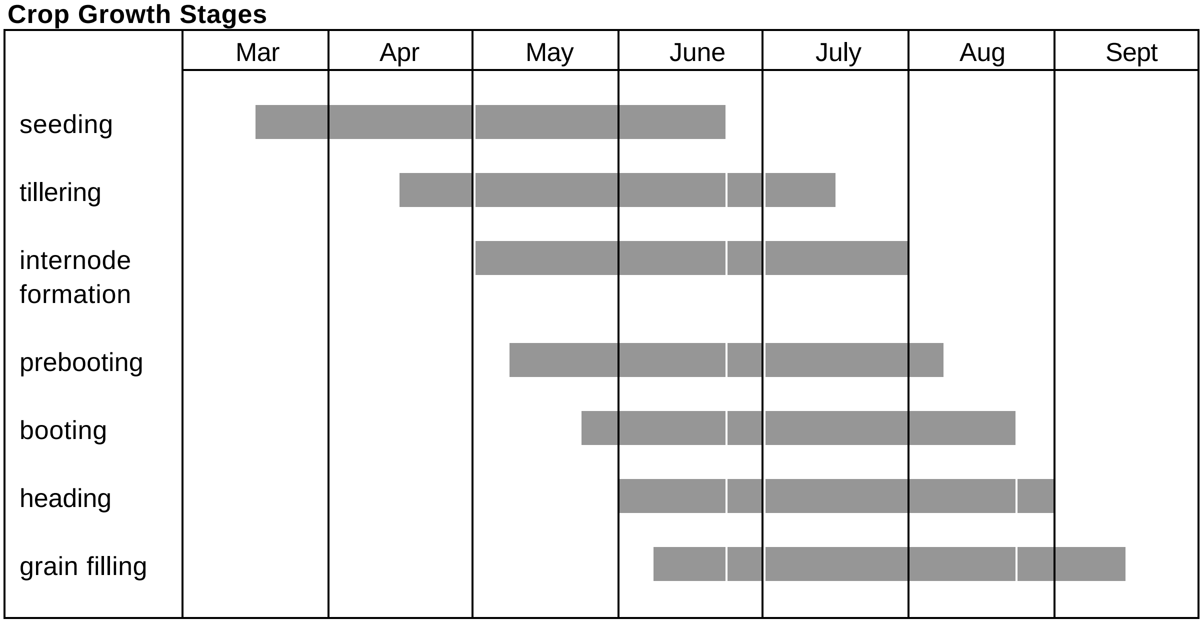
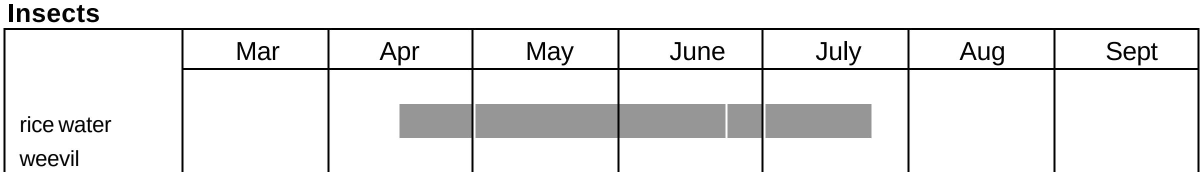
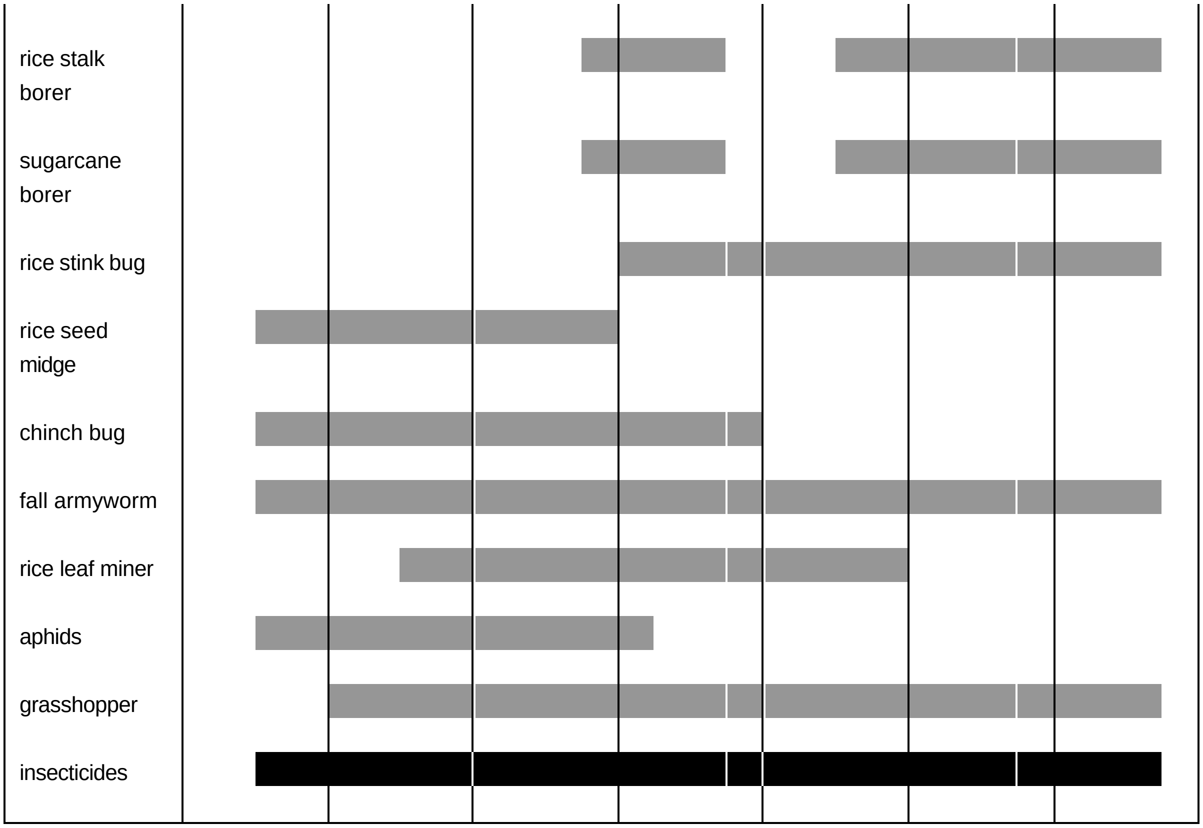


Insects

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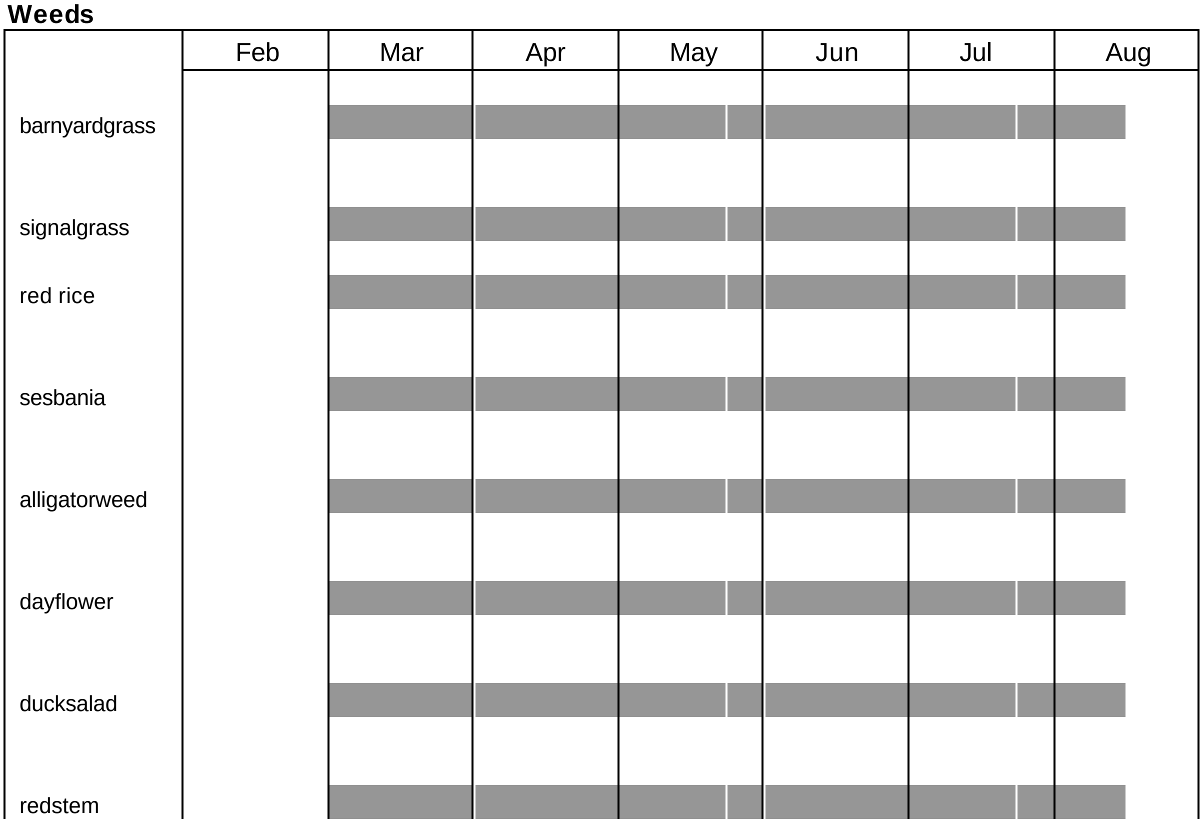
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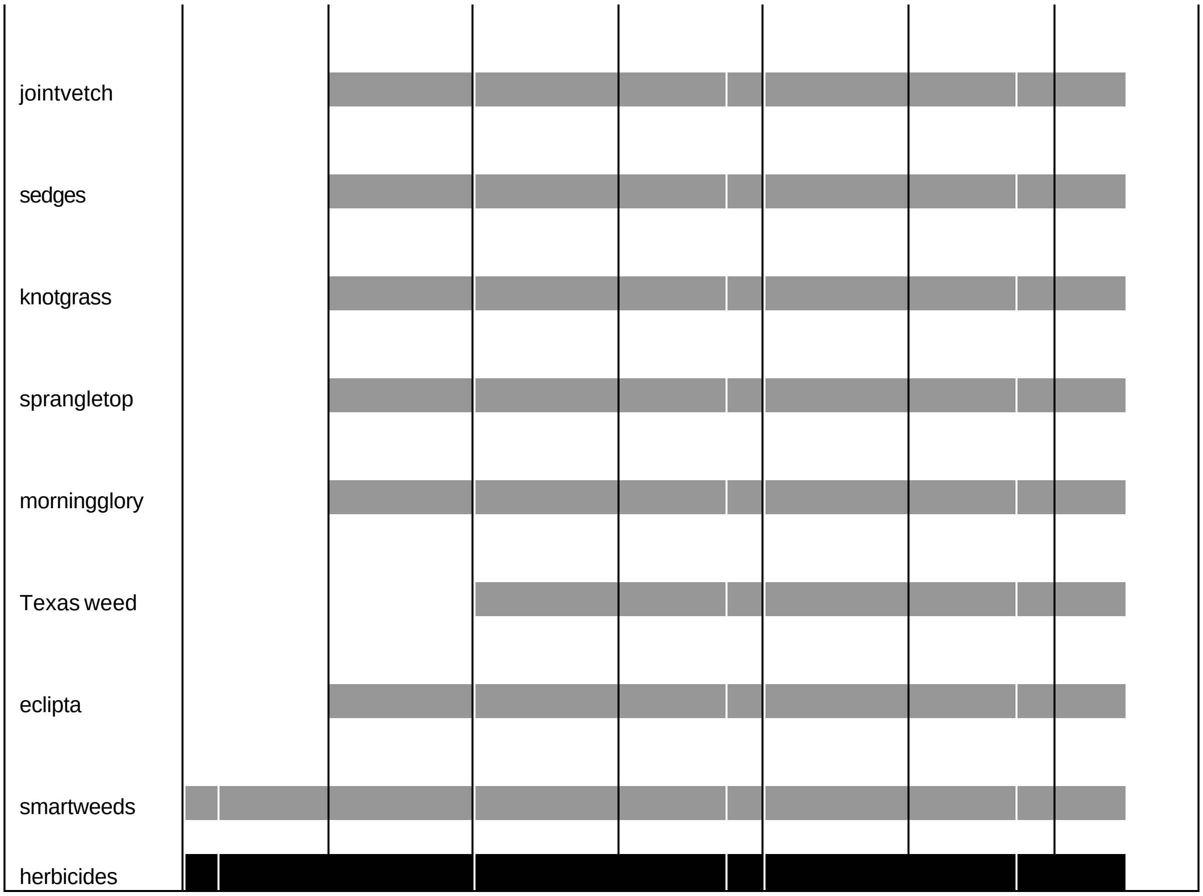
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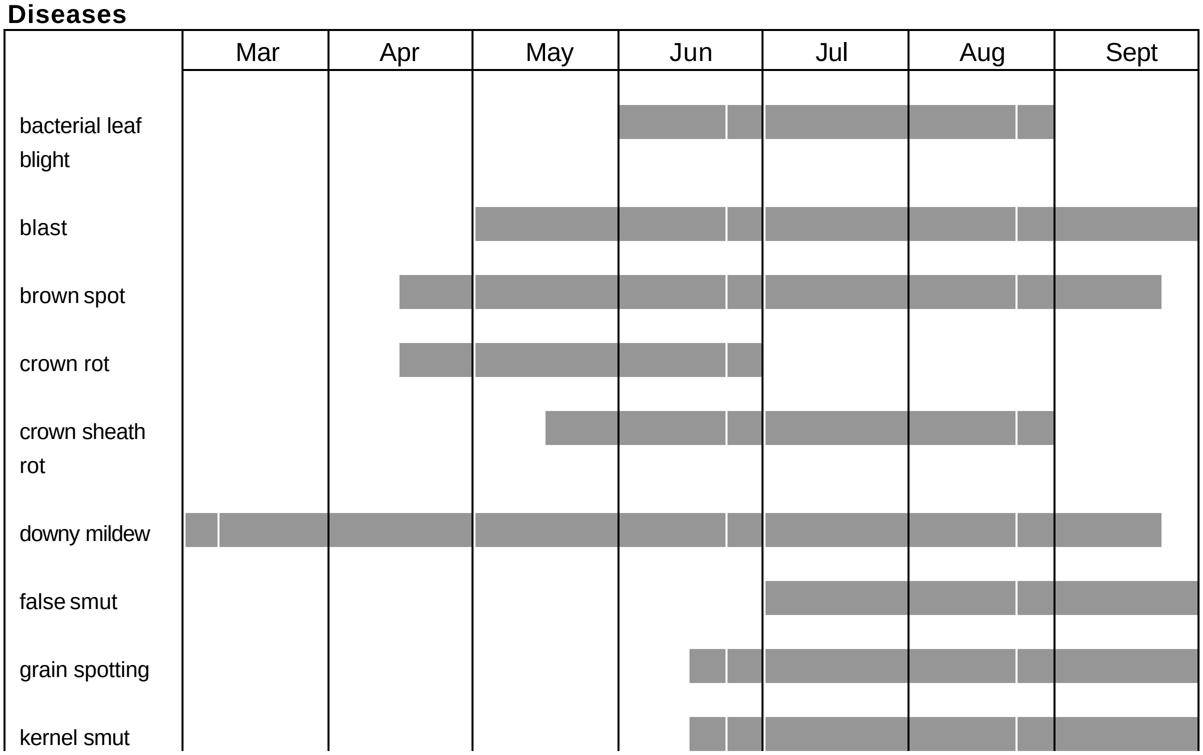
Diseases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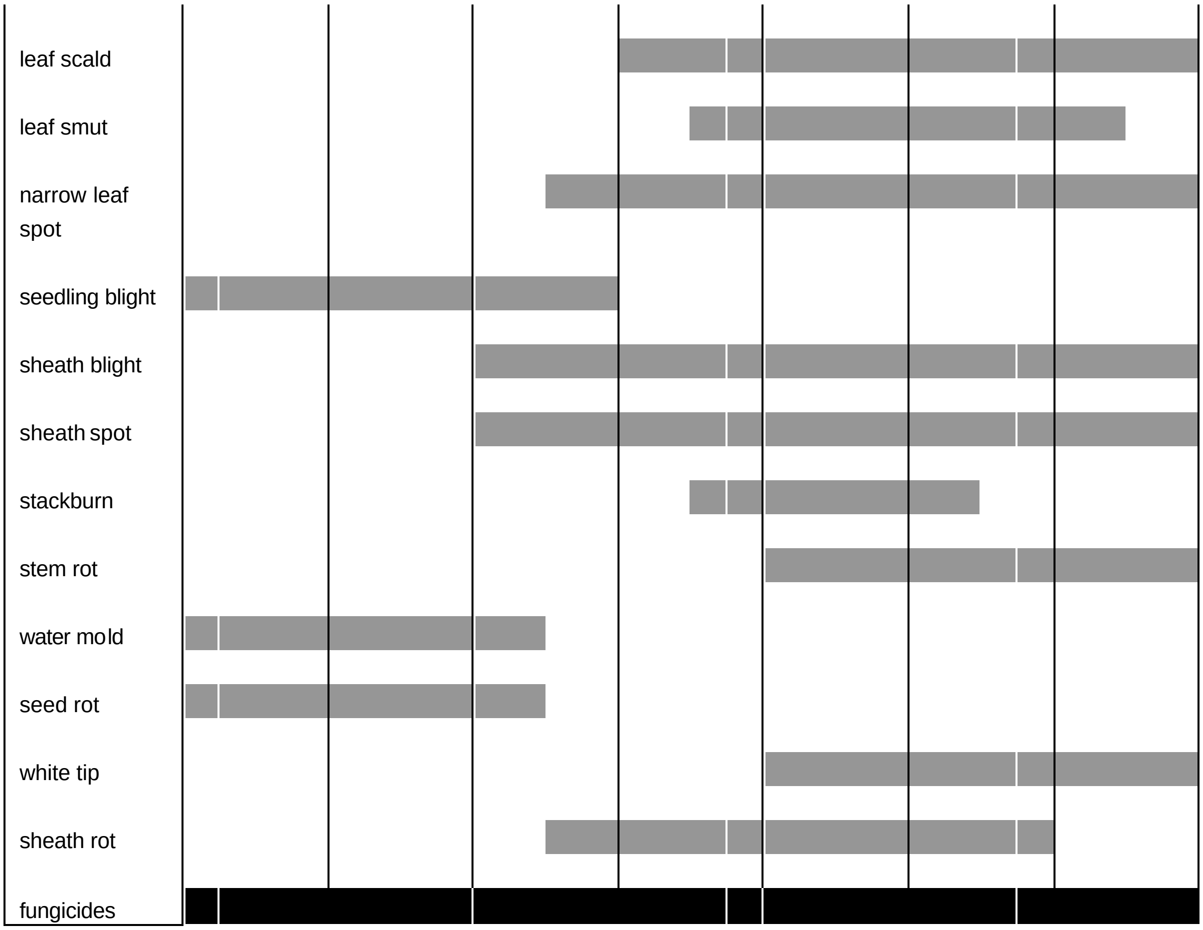
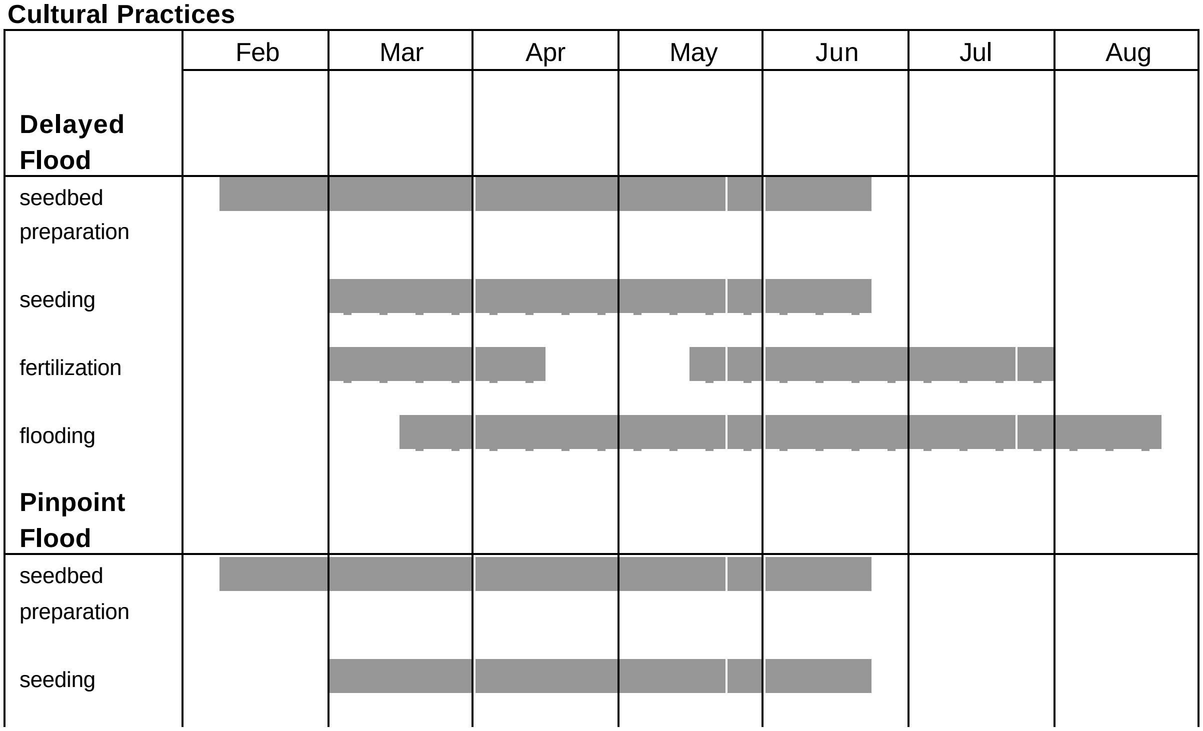
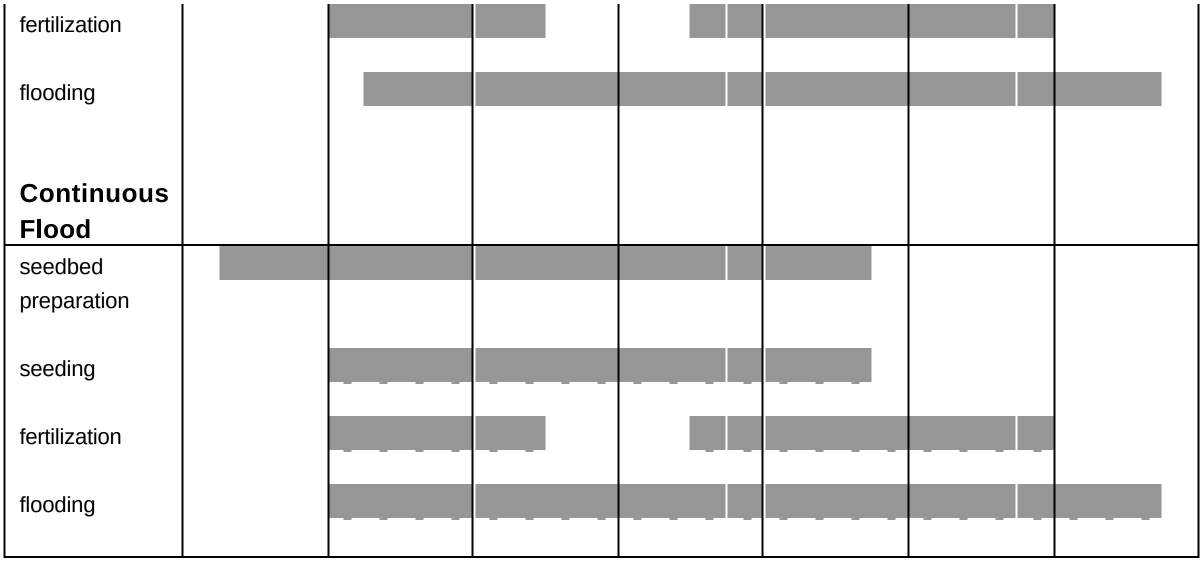


Cultural Practices





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